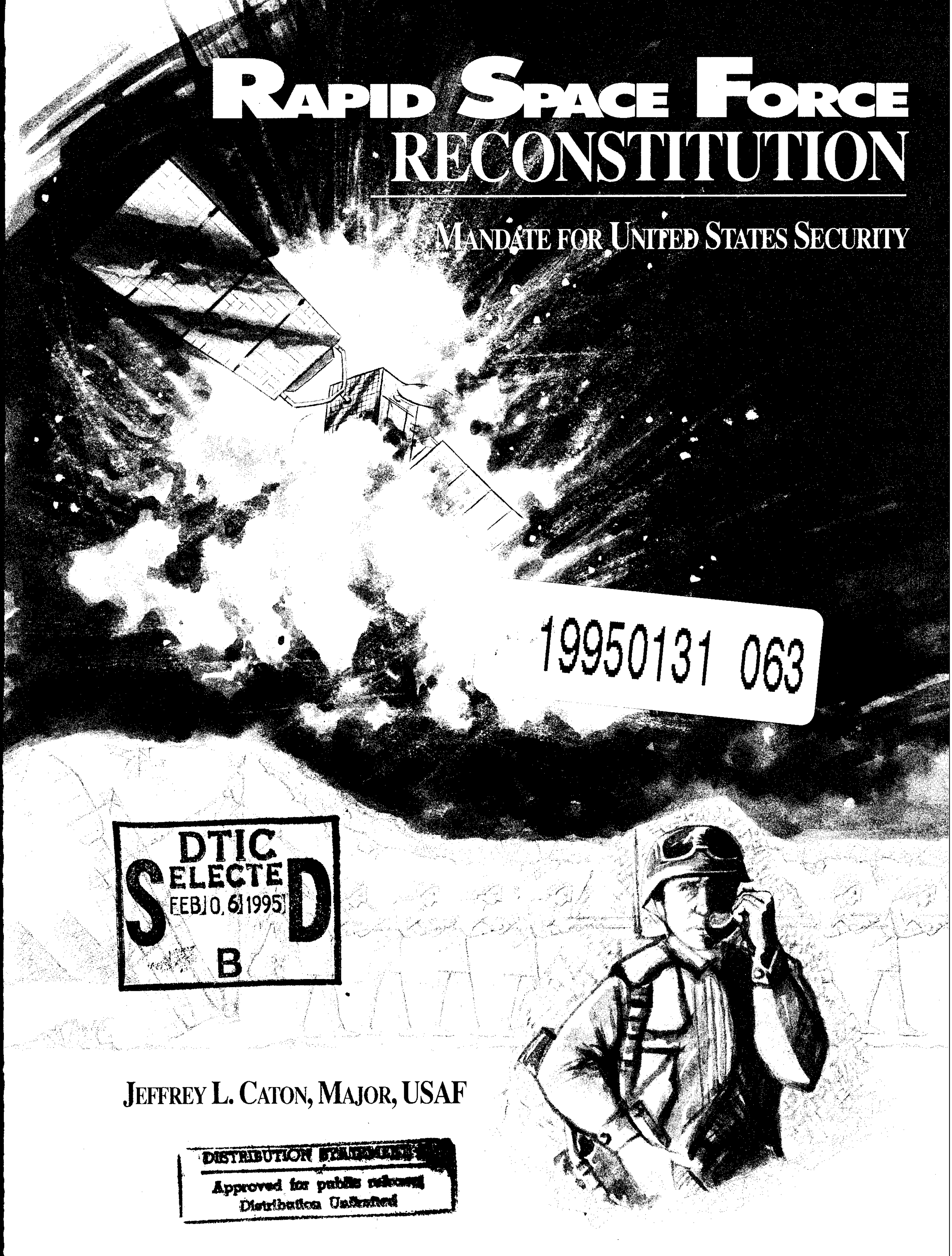
# RAPID SPACE FORCE RECONSTITUTION

## MANDATE FOR UNITED STATES SECURITY







JEFFREY L. CATON, MAJOR, USAF

Research Report No. AU-ARI-94-4

# Rapid Space Force Reconstitution

## *Mandate for United States Security*


JEFFREY L. CATON, Maj, USAF

*ARI Command-Sponsored Research Fellow*
*Air Force Space Command*



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This publication has been reviewed by security and policy review authorities and is cleared for public release.

*To the Bear,*
*the Wolfman,*
*and the NCO corps of the US Air Force*

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# *Foreword*

Radical changes in the global sociopolitical environment over the past five years have altered dramatically the United States' security strategy. A resulting mandate to reduce and streamline our military forces has made them increasingly dependent on the force-multiplying benefits of space systems. This crucial space-based force enhancement is dependent on satellites being available when and where they are needed.

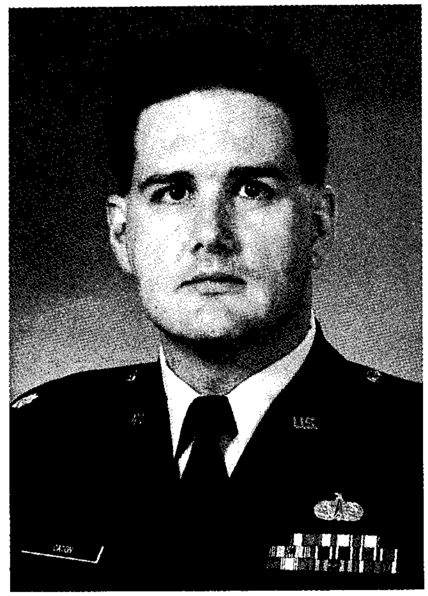
In his research, Maj Jeff Caton analyzes the increasing threat posed by technology proliferation and its implications for our space systems. He proposes the development and employment of rapid space force reconstitution (RASFOR) systems that are necessary to ensure that responsive and flexible space support is always available for the joint war fighter. He challenges some of the traditional approaches to spacelift and provides recommendations for future military spacelift force composition.

RASFOR is an interesting concept which should be evaluated as part of a balanced approach to military spacelift if the United States is to ensure control over the ultimate high ground of space. I commend this study to anyone contemplating the future use of space systems in military operations.

Thomas S. Moorman Jr.

THOMAS S. MOORMAN, JR.
Lieutenant General, USAF
Vice Commander
Air Force Space Command

## *About the Author*



**Maj Jeffrey L. Caton**

Maj Jeffrey L. Caton is the 1993–94 Airpower Research Institute Fellow representing Air Force Space Command at the College of Aerospace Doctrine, Research, and Education, Maxwell Air Force Base (AFB), Alabama. Major Caton is a 1982 distinguished graduate of the University of Virginia Air Force ROTC program with a bachelor of science degree in chemical engineering. He also has a master of science degree in aeronautical engineering from the Air Force Institute of Technology. His professional military education includes Squadron Officer School (correspondence) and Air Command and Staff College (distinguished graduate in residence).

In 1982, Major Caton reported to Aeronautical Systems Division, Wright-Patterson AFB, Ohio, where he was assigned to the F/FB-111 Avionics Modernization System Program Office as a reliability and maintainability engineer. In 1984 he was moved to the Advanced Cruise Missile System Program Office as the system integration engineer responsible for the mission planning system. In 1987 he was selected to attend the Air Force Institute of Technology (AFIT) School of Engineering, Wright-Patterson AFB, Ohio. While there, he was chosen as the representative for the joint Air Force Institute of Technology/von Karman Institute for Fluid Dynamics program to perform five months of research in Rhode-St-Genese, Belgium. Upon return from Belgium and graduation from AFIT, he was assigned to the 6595th Test and Evaluation Group, Vandenberg AFB, California, as chief, launch vehicle test branch. While there, he directed a variety of test flight operations for the Small ICBM, Peacekeeper, and Minuteman missiles (12 total flights); the Taurus space launch vehicle; and the American Rocket Company's commercial hybrid rocket motor. Major Caton also served as the analysis group chairman for the Titan IV Solid Rocket Motor Upgrade formal accident investigation at Edwards AFB, California. He has published six technical papers. Major Caton is currently assigned to US Space Command, Cheyenne Mountain Complex, Colorado Springs, Colorado, in the Space Control Center.

# *Preface*

This study had its genesis in bewilderment and frustration. As I worked with space and missile test and evaluation at Vandenberg AFB, certain questions started to bother me. How could missile systems designed and operated to launch *in minutes* take *months* to launch when they are modified for spacelift? Why does it take *hundreds* of engineers and technicians to launch *one rocket?* Most importantly, why do we continue to gamble hundreds (sometimes thousands) of millions of dollars on a single space launch? Imagine if airlift were performed in the same manner. C-17s would be *built* at the end of a runway, items would be loaded, the aircraft would take off, land, unload, and then be thrown away (or, at best, it would be significantly refurbished for months prior to its next flight). Certainly, things have not always been this way. Where did we go wrong?

In the 1960s, the US decided to pursue a military space program that emphasized *quality* satellites versus a USSR program that was based on satellites in *quantity.* This strategy had a side effect—the higher quality satellites had to be replaced less often, thereby radically decreasing the number of launches required. This situation eventually led to a nonstandard and complex launch infrastructure based on a research and development approach instead of an operational approach. On the other hand, the USSR built a responsive and robust spacelift infrastructure with an impressive and proven surge capability. Thus far, the US strategy has served our nation well—its success was critical to winning the cold war. However, as space technology proliferates in an ever-changing world, so does the potential threat to our satellites. Future conflicts are likely to include the need for satellite replacement or augmentation. Looking toward this future, I developed my primary research question: *Is there a need for a rapid space force reconstitution capability to meet US military combat support requirements?*

As the global sociopolitical environment continues to become more diverse and dynamic, our military forces must become more flexible and responsive. These forces are becoming highly dependent on space-based force enhancement (communications, weather, navigation, and so forth) to accomplish their missions—peaceful and otherwise. The linchpin of our space doctrine is that *satellites must be available when and where they are needed.* Current spacelift systems may not be available to support this doctrine in certain feasible crisis scenarios. Rapid space force reconstitution (RASFOR) systems, using rapid-response spacelift and light satellites, can provide the support necessary to ensure that critical satellites are in place to support the joint war fighter.

This paper discusses the strategic (national policy) and operational (warfighting) mandates for RASFOR. Also, it provides a historical context for our nation's spacelift structure and makes recommendations for the incorporation of RASFOR as part of a *balanced approach* to military spacelift. This is not an advocacy paper for RASFOR systems; many conclusions and recommendations made in the early phases of my research were changed 180 degrees as my research progressed. To avoid the parochialism of some previous studies dealing with spacelift, no specific RASFOR systems are championed (photographs of some existing systems are provided to illustrate the technological feasibility of RASFOR).

The research for this paper was conducted from July 1993 through May 1994. During early 1994, a space launch study was conducted by a team of DOD members led by Lt Gen Thomas S. Moorman, Jr., vice-commander, Air Force Space Command. Since the results of the DOD study were released at the time my research ended, their results are not included in this paper. However, I have reviewed the DOD Space Launch Modernization Plan executive summary and have briefed General Moorman on the results of my research. In comparing these two studies, the following item should be noted. This paper criticizes the military's historical evolutionary approach to spacelift. After reviewing the DOD space launch study, I found a semantic difference in the use of the word "evolutionary." In my paper, I discussed the historically *random* (i.e., unplanned and reactive) evolutionary approach rather than the *managed* (i.e., planned and proactive) evolutionary approach recommended in the DOD study. I prefer to term the study's approach as "synergistic," since it combines many existing subsystems in an organized manner to create improved capabilities other than just performance. In fact, one of the top five priorities of the DOD study was to increase *operability*—basically the same as the *operational utility* that I emphasize as a priority in this paper.

Finally, RASFOR must be considered as an integral part of a *balanced approach* to military spacelift. Its purpose is to augment, not replace, current and future spacelift capabilities. The bottom line is this: RASFOR is a capability that can help the US to ensure control over the ultimate high ground of space.

Jeffrey L Caton

JEFFREY L. CATON, Maj, USAF
Research Fellow
Airpower Research Institute

## *Acknowledgments*

This report would not have been possible without a team effort. Certain team members deserve to be acknowledged for their contributions to this research. Col Bill Anders and Lt Col Jack Kaufmann of the 6595th Test and Evaluation Group (both now retired) provided the support and encouragement necessary for me to land this research assignment and, more importantly, inspired many themes of the actual research. Col Vic Budura, the Space Chair of Air War College and my boss in this effort, helped me maintain a balance in my efforts and showed me the ropes of working with headquarters. Dr Lew Ware of Air Command and Staff College deserves the most credit for making this a useful product—he helped formulate my ideas into layman's text, and he corralled my tendencies to go into too much detail.

The actual content of my research was established and improved through the efforts of many top-notch professionals: Dr Jim Titus and Lt Col Johnny Jones of the Airpower Research Institute; Mr Preston Bryant of Air University Press; Col Dick Szafranski and Col Tom Dickson of Spacecast 2020; Lt Col Randy Joslin of Headquarters AFSPACECOM/XPX; Lt Col Mike Mantz, a fellow research fellow, and Maj Pat Stroman, an Air Command and Staff College seminar mate; and last, but definitely not least, the entire staff of the Air University Library.

In complete sincerity, this effort was possible only through the grace of God and the firm foundation provided by my family. My wife Linda and my children Laura and Danny furnished the support, patience, and love necessary for me to succeed in this endeavor.

## *Introduction*

Radical changes in global political and military balances have occurred in the last five years. In response to these changes, the United States defense strategy has moved away from planning for containment of a monolithic enemy and is moving toward flexible, rapid, regionally oriented response anywhere in the world. Although air, land, and sea power have begun alignment toward this goal, space-based military assets are not prepared for short-notice "come as you are" contingencies that require rapidly deliverable forces.

*This paper argues that national security policy mandates the immediate development of a rapid space force reconstitution (RASFOR) capability.* The paper presents this argument on two levels: *strategic,* based on national policy documents, and *operational,* based on military force requirements for the near-term future. A RASFOR operational concept using rapid-response spacelift and light satellites (lightsats) is presented. After the mandate is established, a key question is addressed: *If the mandate for RASFOR exists, why hasn't it been acted upon?* Based on these discussions, recommendations for implementing RASFOR are presented.

Chapter 1 presents a consistent strategic mandate (as illustrated by a strategies-to-tasks framework) for the United States to develop a rapid space force reconstitution system. Implementing RASFOR directly complies with two of the foundations of the US National Military Strategy—crisis response and reconstitution—which in turn have direct traceability to the grand strategy of the United States.

Chapter 2 discusses the increasing dependence of military forces on space systems. They may be pitted against adversaries who also have military space assets, giving challenge to our space systems during military operations. The proliferation of space technology may allow future adversaries to degrade or destroy our satellites. Also, unanticipated system failures and multiple area coverage requirements may require the immediate placement of satellites into orbit. To meet these challenges, RASFOR is essential to space operations—it can provide the space support tasks necessary to meet joint requirements in the future combat environment. Although alternative operational concepts exist (status quo launch, on-orbit storage, and repositioning), they are inferior to RASFOR.

Chapter 3 examines the many reasons why the mandate for RASFOR has not been followed. The historical approach to US spacelift has been through the progressive modification of ICBM-based space launch vehicles; there has never been a military space launch vehicle designed from scratch. The perceived lack of requirements for RASFOR, although a fallacy, has helped to ensure that the mandate be ignored. Also, the previous and current political environments have not been favorable to new technologies that offer no immediate benefits. Technology is not a barrier to RASFOR; in fact, implementation of a RASFOR system may lead to a fundamental change in the way the US designs and deploys satellites.

US space forces are *not* unrivaled is their war-fighting capability. Credible threats to our satellites exist now within Russia, and many other countries may offer similar

threats in the near future. Development of a RASFOR system is an *essential* step that the US must accomplish to be the number one power in the "high ground" of combat media.

Chapter 4 discusses the numerous benefits offered by rapid space force reconstitution systems: increased capability, operational utility, and flexibility; and decreased vulnerability, risk, and cost. Space doctrine, still in its infancy, does not recognize these advantages. There are unstated assumptions that US satellites will always be in place when we need them and that existing reconstitution methods (repositioning, on-orbit spares) are sufficient. No proactive approach to space force reconstitution during combat is presented.

RASFOR is needed to ensure that critical space assets are always available when and where they are needed. Assured access to space is given lip service in joint and Air Force doctrine; both acknowledge the problems with current spacelift systems, but do not consider the ramifications of these deficiencies in a combat environment. This lackadaisical treatment of space force reconstitution in current doctrine could lead to disaster in our next space war.

Chapter 5 presents recommendations for the implementation of RASFOR. The essential nature of RASFOR must be emphasized throughout space doctrine. If satellites are not available during wartime, then current space doctrine falls apart. Therefore, RASFOR should be added as a tenet of US space doctrine—it must be recognized as a key enabler for space doctrine.

The options provided by a RASFOR system must be clearly understood by campaign planners, especially its ability to react to short-notice crises. RASFOR should be integrated into space campaign doctrine. Requirements must be determined as a basis for RASFOR development, and these requirements must be coherent with future combat scenarios. As a minimum, the ability of current US space forces to meet two simultaneous major regional conflicts should be evaluated to determine the scope of RASFOR required.

Once clear operational requirements have been determined for a RASFOR system, its force elements should be developed and acquired. The Air Force should lead this effort with the participation of all armed services. RASFOR should be developed with a military-first approach. RASFOR technologies and systems should be made available to commercial industry. Economics should not be the main driver in system development, however, and technological spinoffs are not guaranteed. Acquisition of RASFOR systems should support an implementation time frame of the years 2002–2007. This time frame coincides with the projected time that current satellites (existing or in production) will require replacement to fulfill military needs (in accordance with current DOD space investment strategy).

The actual employment of RASFOR systems should include a balance of elements dedicated for continuous alert and elements dedicated to routine replacement (with the option of moving to alert status during a crisis). Also, RASFOR systems should maintain the operational flexibility necessary to use their spacelift elements as force application platforms.

Rapid space force reconstitution offers responsive and flexible space support to the war fighter. It deserves serious consideration and advocacy by joint war planners to ensure that future war fighters have critical space-based support when and where they need it.

# Chapter 1

# The Strategic Mandate

*A peaceful, gain-loving nation is not farsighted, and farsightedness is needed for adequate military preparation.*

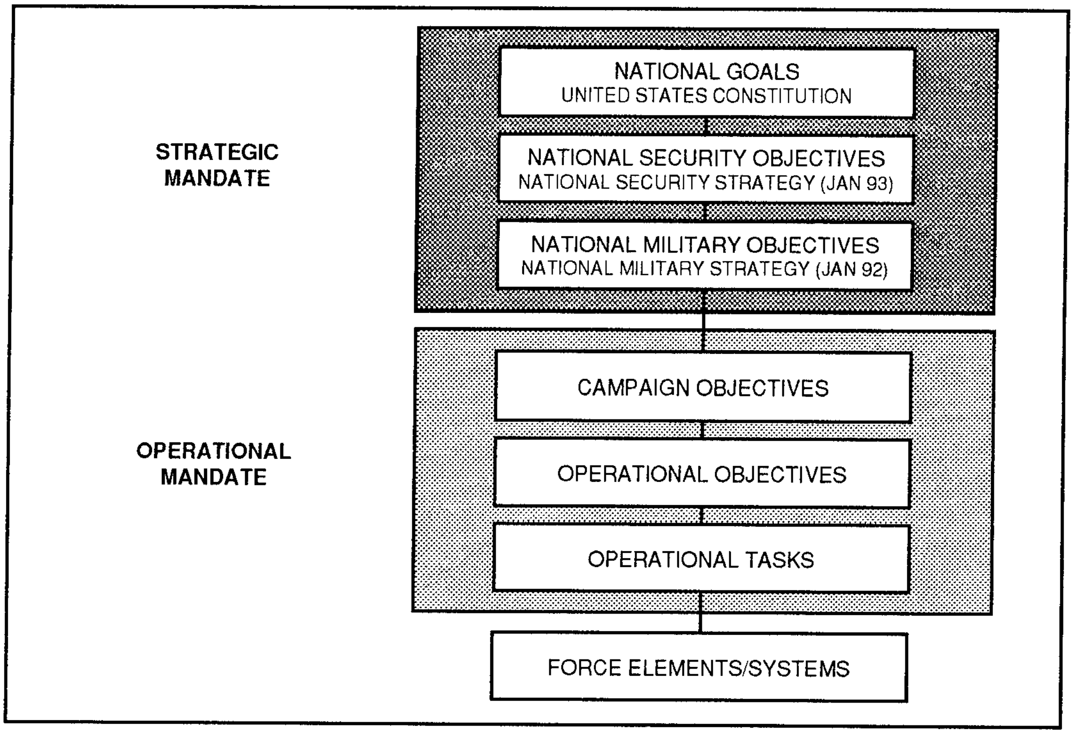
—Alfred Thayer Mahan

The world has been radically transformed in the last five years: communism has declined and free market democracy has expanded; the threat of thermonuclear war has lessened; the world has become more interdependent; and the United States has emerged as the preeminent world power.[1] As the nation entrusted with the leadership to ensure a stable and democratic world order, the scope of US national security strategy must cover the entire world. Faced with increasing responsibilities and decreasing force size, the US military is becoming increasingly dependent on force-multiplying support from space to accomplish its missions.[2] This chapter examines the strategic mandate for rapid space force reconstitution (RASFOR)—a capability that is necessary to ensure that critical space support is always available to the joint war fighter.

## Strategies-to-Tasks

The specific tasks that military forces, including space systems, must accomplish can be identified through an approach that systematically follows a requirements path from the highest level (national goals) to the lowest level (force elements). This methodology is called "strategies-to-tasks" (STT), and one of its primary purposes is to identify high priority needs for improved capabilities. In 1993, Gen Merrill McPeak, chief of staff of the Air Force, directed that the STT approach be used to identify force requirements out to the year 2015.[3]

The STT framework is illustrated in figure 1. The first three levels of the diagram—national goals, national security objectives, and national military objectives—comprise the *strategic mandate*. The next three levels continue the path into the campaign objectives, operational objectives, and operational tasks, thus presenting an *operational mandate*. The final level identifies the force elements or systems that fulfill the strategic and operational mandates.[4]




**Source:** David E. Thaler, *Strategies-to-Tasks: A Framework for Linking Means and Ends,* Rand Report MR-300-AF (Santa Monica, Calif.: Rand Corporation, 1993).

**Figure 1. Strategies-to-Tasks Hierarchy**

## Strategic Mandate

The national goals of the United States, defined in accordance with the Constitution, form the top level of the STT hierarchy.[5] Branches of government defined by the Constitution must in turn establish and implement security and military strategies coherent with this grand strategy. The *National Security Strategy of the United States* (second level of STT) lists military-related challenges that are numerous and complex. Significant threats include weapons proliferation (advanced conventional weapons, ballistic missiles, and weapons of mass destruction), terrorism, and international drug trade. However, regional instabilities and their threat to global security represent the primary focus for our military forces.[6] Current Department of Defense (DOD) documents base US force planning on our ability to face two simultaneous major regional conflicts. These scenarios depict short-notice conflicts with modest US force size in the region at the commencement of hostilities.[7]

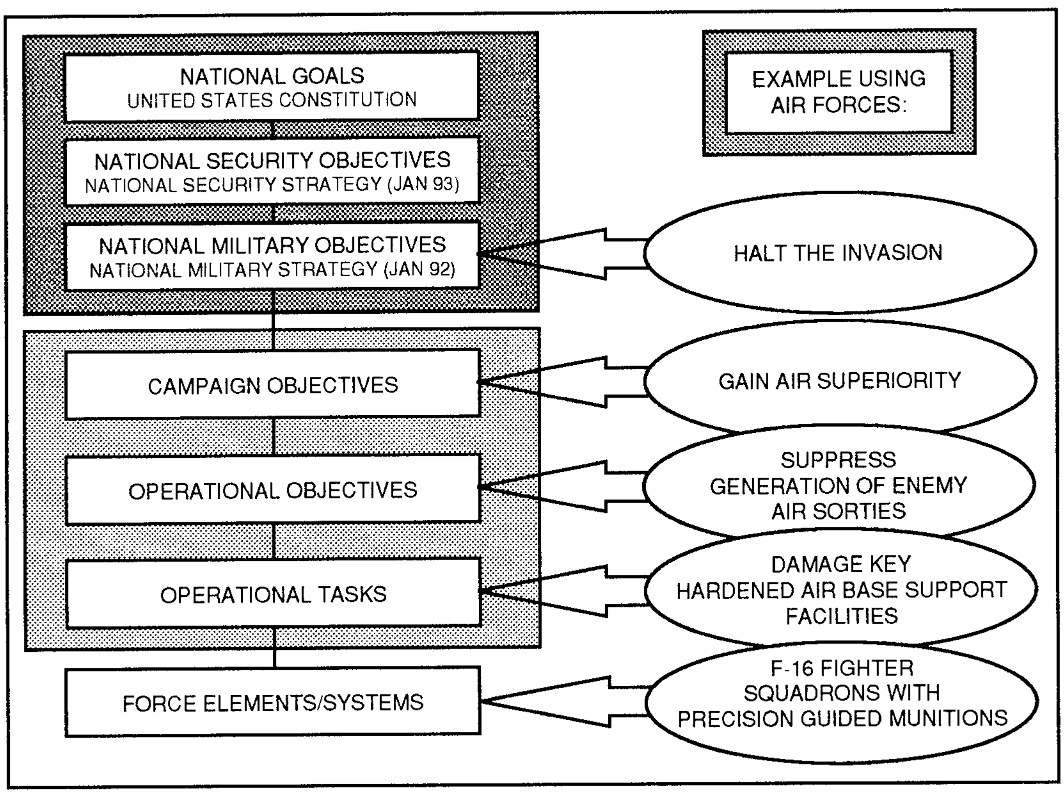
The fundamental objective of the armed forces is "to deter aggression and, should deterrence fail, to defend the nation's vital interest against any potential foe" (third level of STT). To meet this objective, the current National Military Strategy has four foundations, which are derived from the National Security Strategy: strategic deterrence and defense, forward presence, crisis

response, and reconstitution.[8] This strategy will be implemented by a military with smaller force levels and fewer forward bases, necessitating increased dependence on the force-multiplying capabilities of space systems.[9]

## Operational Mandate

Campaign objectives, and the operational objectives and operational tasks which cascade from them (fourth, fifth, and sixth levels of STT), are usually based on the threat to US interests and the capabilities of US and allied forces located in a specific region.[10] This operational mandate can be illustrated with two examples related to short-notice regional conflict. One utilizes air forces, the other utilizes space forces. Both are based on one of the scenarios used by the 1993 Bottom-Up Review (a remilitarized Iraq invades Kuwait).[11] This scenario lists four phases for US combat operations. Examples will use the Phase 1 objective—halt the invasion[12]—as the culmination of the strategic mandate upon which numerous campaign objectives can be derived.

**Air Forces Example: Air Superiority.** Figure 2 illustrates the utilization of air forces. The campaign objective (fourth level of STT) is to gain air superiority. A key operational objective (fifth level of STT) derived from this is to suppress the generation of enemy air sorties. One of the operational



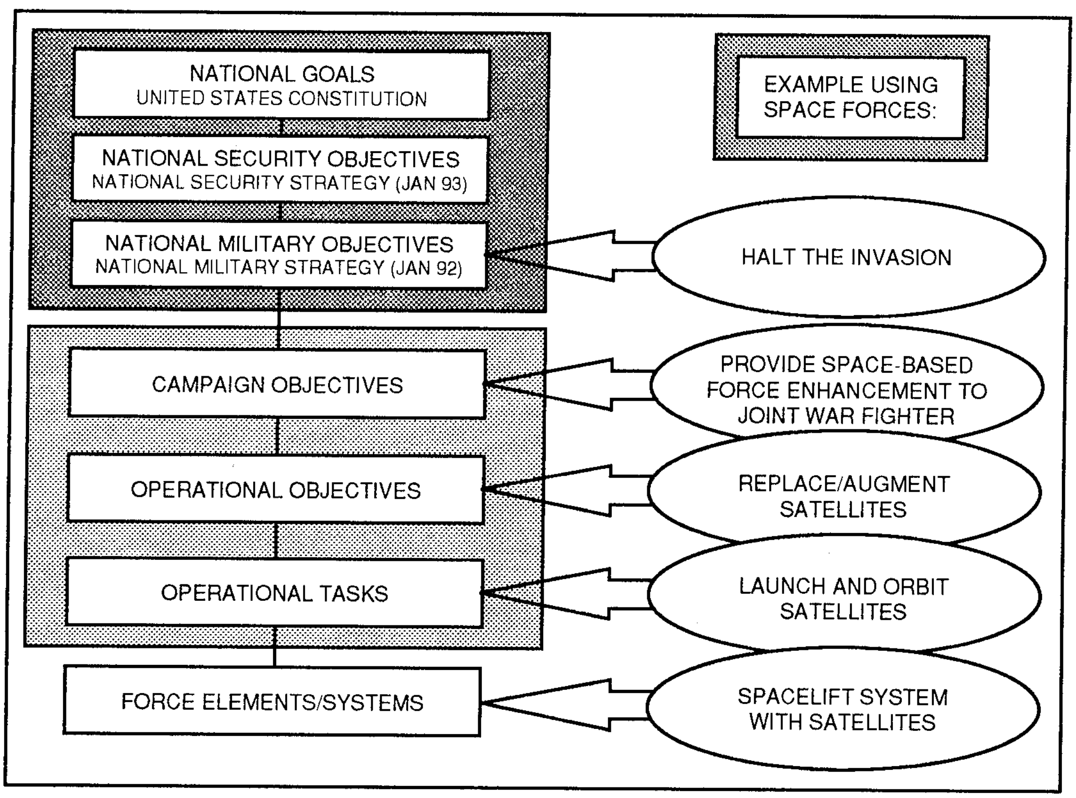

**Source:** David E. Thaler, *Strategies-to-Tasks: A Framework for Linking Means and Ends,* Rand Report MR-300-AF (Santa Monica, Calif.: Rand Corporation, 1993).

**Figure 2. Strategies-to-Tasks Example Using Air Forces**

tasks (sixth level of STT) required to accomplish this is to damage key hardened air base support facilities. The force elements (final level of STT) selected for this task are F-16 fighters using precision guided munitions. The STT has given this weapon system direct traceability to the grand strategy of the United States.

**Space Forces Example: Force Enhancement.** Another key campaign objective required for this scenario is to provide space-based force enhancement to the joint war fighter. Figure 3 illustrates an STT framework that meets this objective. Ensuring that this force-enhancement capability is available may require the augmentation or replacement of existing satellite constellations. Accomplishing this operational objective requires the operational tasks of launching and orbiting satellites. The force elements selected for this task are spacelift systems with the appropriate satellites.

The previous example provides a clear linkage between space-based force enhancement and space force reconstitution (the replacement and augmentation of satellites). Since the strategic mandate emphasizes short-notice crisis response, this reconstitution must be accomplished in a timely manner if it is to provide the force enhancement when needed. The current published doctrine concerning the deployment of space forces (Air Force Manual [AFM] 1-1) confirms this:




**Source:** David E. Thaler, *Strategies-to-Tasks: A Framework for Linking Means and Ends,* Rand Report MR-300-AF (Santa Monica, Calif.: Rand Corporation, 1993).

**Figure 3. Strategies-to-Tasks Example Using Space Forces**

> **Rapid-response spacelift must be available to emplace and replace critical space assets.** The US military relies extensively on space assets for many critical missions. In a crisis, it may be necessary to concentrate assets quickly. Failure of these assets or their destruction by enemy action could lead to disastrous consequences unless they can be quickly replaced.[13]

However, doctrine and force structure are not always complementary; we must examine existing US spacelift systems to determine whether they are capable of accomplishing space force reconstitution.

## Current Capabilities

In 1992, a comprehensive Blue Ribbon Review of Air Force space policy, organization, and infrastructure was conducted. One of its key findings: "In the future, the need for space support in major conflicts will likely exceed peacetime capabilities in terms of capacity, interoperability and flexibility."[14] This points to the need for spacelift that is not only responsive, but is also capable of rates and volumes greater than normal peacetime operations.

Top Air Force officials agree that spacelift is an essential military role, and that it requires extensive improvement. Secretary of the Air Force Sheila Widnall stated that access to space is fundamental to military security, but noted that "We can't get there from here with the ICBM derivatives now used as launch vehicles."[15] Lt Gen Thomas Moorman, vice-commander of Air Force Space Command (AFSPC), noted that "our current launch vehicles and their associated processes do not provide the responsiveness needed to rapidly replace or augment on-orbit assets." In addition to being too slow, the US launch infrastructure is vulnerable, inflexible, and expensive.[16] The Air Force white paper, *Global Reach—Global Power*, also recognizes this deficiency: "Clearly we need increased launch capability to ensure unimpeded access to space."[17]

For examples of how vulnerable this system is, consider the first two weeks of August 1993. On 2 August, a Titan IV launch from Vandenberg Air Force Base (AFB) exploded at 101 seconds into its flight. The cost of the failure is estimated to be between one and two *billion* dollars. But the effects of this incident go beyond just the economics: it "put Titan 4 launches on hold and threatens *further* delays in the deployment of *key national security spacecraft*" (emphasis added).[18] Nor does the Titan story end there. This accident also delayed two Titan IV vehicles set for launch from Cape Canaveral. These two vehicles were to fly with the Centaur upper stage, which itself had been recently grounded due to its two consecutive failures on Atlas vehicles.[19]

Spacelift problems during this two-week period were not limited to expendable boosters. On 12 August, the space shuttle Discovery's main engines shut down three seconds before liftoff, grounding the orbiter for at least three weeks. This was the third launch attempt for this Discovery mission, mechanical failures having caused launch aborts on 17 July and 24 July. While shuttle delays have become commonplace, this specific delay marked the fourth on-pad main-engine shutdown for the shuttle fleet (the second one in 1993).[20] The Discovery finally

lifted off on 12 September, after six delays and four countdowns (a total of 57 days from first launch attempt).[21]

To have a superior war-fighting space force, we must be able to place satellites into orbit when and where we want to—we must have control over the space lines of communication. A key element of this control is access, making a rapid-response spacelift system an essential element of future combat forces.

## RASFOR Operational Concept

The development of rapid-response spacelift could fundamentally change US space operations, but only if it is coupled with a parallel change from complex, heavy, long-life satellites to simpler, smaller, shorter-life satellites called lightsats. In war-fighting terms, the big satellites are like B-17s in space—self-defending, capable, and an easy target for a determined foe. In contrast, the use of lightsats coupled with a rapid-response spacelift system could dramatically increase space combat support capability (discussed in chapter 4). This combination of systems—rapid-response spacelift and lightsats—are the force elements necessary to accomplish rapid space force reconstitution.

For this paper, RASFOR is defined as the capability to rapidly replace or augment existing military satellites in a reliable, responsive, and flexible manner to meet short-notice crises or contingencies that cover the full spectrum of military operations. This RASFOR capability concentrates on sending lightweight payloads (500–2,000 pounds) into low-earth orbit. The operational concept for RASFOR is illustrated in figure 4, which outlines the actions that supporting commands (US Space Command and individual service space commands) must take to provide RASFOR.[22] When space support is requested by a combatant commander, the supporting command will observe existing space assets, assess their ability to meet the combatant commander's needs, and decide whether RASFOR is required (other options are discussed in chapter 2). Once the decision is made to use RASFOR, the supporting commands will prepare and execute the mission: launch the rapid response spacelift vehicle, orbit the lightsat, perform on-orbit checkout, and task the lightsat. During the RASFOR mission, the supporting commands will also perform dynamic engagement control functions such as range tracking and control. More details on the RASFOR concept will be presented in chapter 4.

## Summary

There is a consistent strategic mandate (as illustrated by strategies-to-tasks) for the United States to develop a rapid space force reconstitution system. Implementing RASFOR directly complies with two of the foundations of the US National Military Strategy—crisis response and reconstitution—which in turn have direct traceability to the grand strategy of the United States. This chapter has

presented the top-down approach (STT) to RASFOR. To complete this analysis, chapter 2 will examine the bottom-up needs for RASFOR—it will determine whether US military operations require RASFOR.

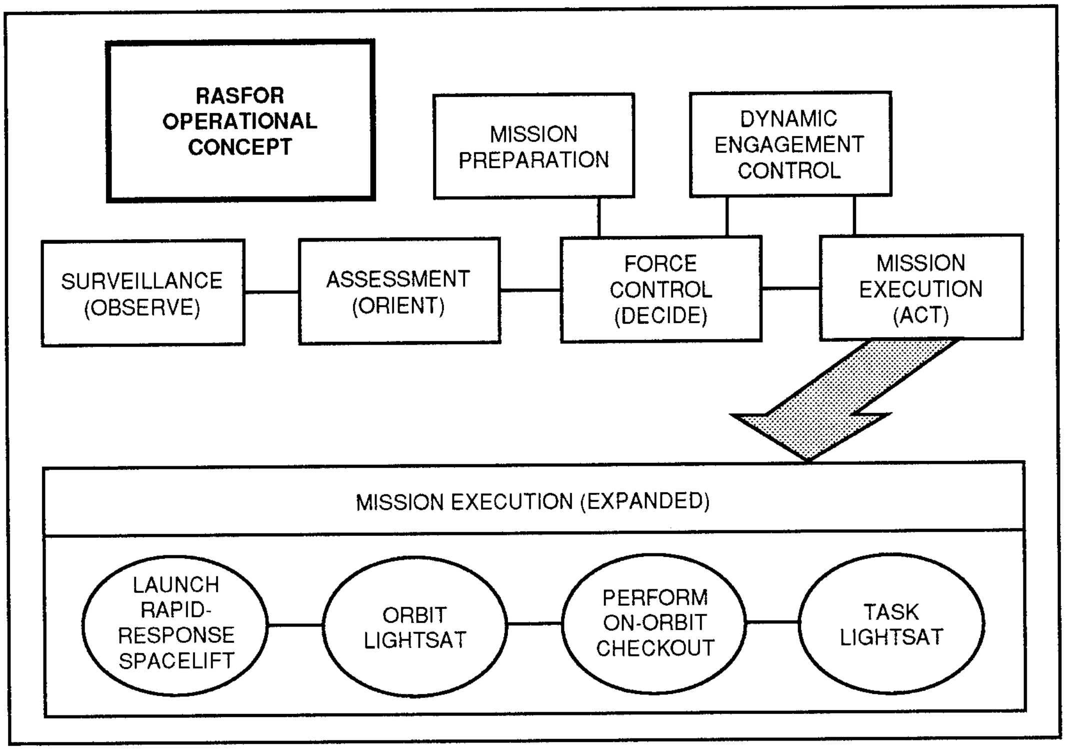



**Figure 4. Rapid Space Force Reconstitution Operational Concept**

**Notes**

1. *National Security Strategy of the United States* (Washington, D.C., The White House, January 1993), i–ii.
2. Secretary of the Air Force Donald B. Rice, *The Air Force and U.S. National Security: Global Reach—Global Power*, white paper (Washington, D.C.: Department of the Air Force, June 1990), 12.
3. David E. Thaler, *Strategies-to-Tasks: A Framework for Linking Means and Ends,* Rand Report MR-300-AF (Santa Monica, Calif.: Rand Corporation, 1993), iii, 3.
4. The strategies-to-tasks model referenced in *Strategies-to-Tasks* does not break out the hierarchy in the strategic and operational mandate. This is a nomenclature unique to this paper.
5. *Mandate* is defined as "an authoritative instruction or command" (*Webster's II New Riverside University Dictionary* [Boston: Houghton Mifflin Company, 1984], 722). Embedded in this definition is the concept of authority. For the United States, this authority is the US Constitution, which provides the grand strategy framework necessary to "provide for the common defense."
6. *National Security Strategy of the United States*, 1.
7. Les Aspin, *The Bottom-Up Review: Forces for a New Era* (Washington, D.C.: Department of Defense, 1 September 1993), 6.

8. *National Military Strategy of the United States* (Washington, D.C.: The Pentagon, January 1992), 6–8.

9. Rice, 12.

10. Thaler, 4.

11. Aspin, 5.

12. Ibid., 7.

13. AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force,* vol. 1, March 1992, 14. This quote is found in paragraph 3–6c, which discusses the force enhancement role of aerospace forces.

14. *Blue Ribbon Review of the Air Force in Space in the 21st Century* (Washington, D.C.: Department of the Air Force, 1992), 9–11, 15.

15. Secretary of the Air Force Sheila E. Widnall, "Women in Aerospace and New Directions in Space Engineering and Planning" (Remarks delivered at The Aerospace Corporation, El Segundo, Calif., 26 August 1993, as part of Woman's Week Program sponsored by the Aerospace Women's Committee), 3. In this speech, Secretary Widnall stated that the United States' share of free world commercial payload launches dropped from 80 percent to 30 percent within the last 10 years.

16. Lt Gen Thomas Moorman, "The 'Space' Part of 'Aerospace'," *Comparative Strategy* 12, no. 3 (July–September 1993): 255.

17. Rice, 13.

18. Bruce A. Smith, "Explosion Halts Titan 4 Launches," *Aviation Week & Space Technology* 139, no. 6 (9 August 1993): 22. The "further delay" statement refers to the fact that the Titan flights were already well behind schedule. This was due in great part to the two-year grounding of the Titan fleet that followed a 1986 in-flight accident which destroyed a Titan 34D vehicle. For more details see Bruce A. Smith, "Titan 4 Officials Focus on Burn-Through," *Aviation Week & Space Technology* 139, no. 8 (23 August 1993): 26.

19. James T. McKenna, "Failure Stymies Bid to Launch Titan Centaur," *Aviation Week & Space Technology* 139, no. 7 (16 August 1993): 73.

20. James T. McKenna, "Discovery Launch Scrub Disrupts Shuttle Schedule," *Aviation Week & Space Technology* 139, no. 7 (16 August 1993): 26. This delay put "NASA in a bind" and prompted them to push one mission into 1994, and to delay the first few missions for that year up to a month.

21. James T. McKenna, "Discovery Crew Tests Hubble Repair Tools," *Aviation Week & Space Technology* 139, no. 12 (30 September 1993): 36.

22. Thaler, 13. Figure 4 is based on a generic operational concept framework presented in this report.

## Chapter 2

# The Operational Mandate

*The intensely conservative among the military are always proved wrong, because changes in armaments over the past century have been altogether too rapid and drastic to offer any cover to those who will not adjust.*

—Bernard Brodie

The Air Force mission is "to defend the United States through control and exploitation of air and space."[1] This control and exploitation will be key to successful military operations in the future, whether they be in a combatant role or a noncombatant role. One thing is certain, the US can't control and exploit space from the ground—it must have a military presence in the space medium. Because of this, rapid space force reconstitution will play an increasingly greater role in military operations. This chapter presents the operational mandate for RASFOR by examining the nature of space support for future military operations and by determining whether RASFOR is essential to successful space operations.

## Space Operations

Space systems have supported operational commanders for over three decades. In December 1988, space operations were brought to the forefront of Air Force operations via space policy introduced by Secretary of the Air Force Edward C. Aldridge, Jr., and Air Force Chief of Staff Gen Larry D. Welch. Two of the key tenets of the policy were that "(1) the future of the Air Force is inextricably tied to space and (2) space power will be as decisive in future combat as air power is today."[2] Currently, many systems provide essential military services: the Defense Meteorological Satellite Program (DMSP) provides detailed meteorological data; the Defense Satellite Communications System (DSCS) provides communications; the Global Positioning System (GPS) provides navigation and timing data;[3] and the Defense Support Program (DSP) provides ballistic missile early warning data.[4]

Space systems have been utilized in many well-known military operations: El Dorado Canyon (Libya raid in 1986), Earnest Will (Persian Gulf in 1988), and Just Cause (Panama in 1989), to name a few.[5] Use of space systems in these operations was incomplete and often ad hoc, thereby allowing only a subset of the full range of space systems to come into play.[6] The most

extensive use of space in military operations to date occurred during operation Desert Storm, popularly termed *the first space war*. Space systems were the first systems on scene, and they provided a variety of support to Navy, Army, Marine, and Air Force war fighters.

Military satellites (DMSP, DSCS, GPS, DSP) helped Patriot batteries to perform theater ballistic missile defense,[7] supported "Scud hunting" interdiction missions,[8] and provided at least 85 percent of intratheater and intertheater communications.[9] These systems were supplemented by highly capable civilian satellite systems. SPOT (France) and LANDSAT (US) systems directly supported military planning and operations by providing remote sensing data for the preparation of maps, plotting of major vehicle movements, bomb damage assessment, and aircraft strike mission simulation.[10] At least six other civilian satellite systems were reported to have been used during the war.[11]

Although Operation Desert Storm used space assets to great advantage, there remains room for improvement, especially in the interface with military users. Lt Gen Thomas Moorman offered the following observations:

> The importance of Operation Desert Storm as a catalyst for accelerating the future development of tactical space applications cannot be overstated. However, this conflict also underscored certain shortcomings in our use of space. Operational planning for the use of space systems was not well developed when Iraq invaded Kuwait in August 1990. Military planners took advantage of the five months preceding Desert Storm to get ground- and space-based assets into the theater and to school the users in how to better employ space products.[12]

## Future Environment for Military Operations

The current US military force structure is based on operations that include "come-as-you-are" military deployments characterized as "spontaneous, often unpredictable crises." These regionally oriented operations, called major regional conflicts, will require "fully-trained, highly-ready forces that are rapidly deliverable, and initially self-sufficient."[13]

### Space Operations Tasks

To meet the requirements of future military operations, US military strategy calls for "an extensive space capability" with "a wide variety of space systems." Four specific tasks are identified:

- *space control* (combat against enemy forces in space and their infrastructure);
- *force application* (combat against enemy land, sea, air, and missile forces);
- *force enhancement* (support for land, sea, and air forces); and
- *space support* (satellite control and launch capability).[14]

Operation Desert Storm demonstrated the successful application of two of these tasks. The use of DSP satellites for Scud launch warning and the extensive use of space-based weather, communication, and observation data are examples

of force enhancement; the day-to-day tracking and control of satellite systems during the war is an example of space support. Desert Storm also fits the basic characteristics of the hypothetical scenarios used to plan our future force structure. Therefore, the space support provided during Desert Storm represents the *minimum* space support required for future conflicts.[15]

### Growing Dependence on Space Assets

It is clear that future military commanders will want to make full use of space assets as force multipliers. To help facilitate this, each military service established its own space command between 1982 and 1988. In 1985, US Space Command (USSPACECOM), a unified combatant command, was established.[16] These commands actively support an ongoing initiative to provide space support to joint-force tactical units. Called TENCAP (Tactical Exploitation of National Capabilities), this program includes the development of systems which could allow air and surface forces to receive and sort intelligence data directly from space.[17] This capability gives US forces the edge in "information dominance" which may be required for conducting parallel warfare in the future.[18]

### Space Technology Proliferation

Planners and commanders must recognize that the operating conditions in space will change significantly in the future. Lt Gen S. Bogdanov, chief of the former Soviet general staff's operational research center, points out that because "Iraq did not have the necessary countermeasures, US space means functioned under test bed conditions."[19] Simply put—no one offered any significant challenge to our "high ground" in this conflict. This should be viewed as an anomaly; the future will see a multinational proliferation of military space capabilities.[20]

During Desert Storm, a LANDSAT-type system would have provided resolution sufficient to detect corps-size deployments. Had this capability been available to Iraq, it could have revealed preparations for the allied flanking maneuver to Saddam Hussein, thereby threatening the success of the ground campaign. The situation is not improving; the technologies for civil and military space systems are increasingly overlapping. Commercial satellites can easily be improved to provide tactical ballistic missile early warning and multispectral imagery with resolution sufficient to identify ground-based military hardware. It is projected that by 1995 the probability of detecting events (using commercially available space data) in a Desert Storm-type scenario will be 50 percent for an event lasting half a day, and 100 percent for an event lasting two and a half days.[21] Since such capabilities will most likely be available to future adversaries, we need to ensure that US satellites can match or exceed the enemy's capabilities, and that they are available.[22]

Commercial launch vehicles can also be modified to provide a military capability—that of a long-range ballistic missile or an antisatellite weapon platform.[23] Because of the commercial and military advantages offered by space

systems, many countries are actively pursuing organic space capabilities (launchers, satellites, and infrastructure).[24] This proliferation of military-capable space systems will present great challenges to war fighters in the future.

## Challenges to Space Systems

There are many situations that may challenge our existing satellites and require their replacement or augmentation. No matter how well designed and built a satellite is, it is still subject to the random failure of components (i.e., not involving actions by hostile forces) which may render subsystems, or the entire system, useless. External environmental conditions (e.g., micrometeors, solar flares) may contribute to these failures. If such a failure occurs on a satellite that is critical to ongoing military operations, it may be necessary to replace it immediately.

### Shared Satellites

The "global reach" of US forces may require deployment to geographic areas not covered by existing space assets. Even though certain satellites have limited maneuver capabilities, it may not always be possible or practical to move satellites to cover deployment areas. A satellite may need to be placed in a unique orbit to cover the theater of operations.

If the US becomes involved in two conflicts at the same time, existing space assets may not be able to support both theaters. If the theaters are too close together, then they may have to share satellites—their demands may saturate or overload existing satellite capabilities. If the theaters are far apart, then they may compete for limited satellites. In either case, the integration and coordination of limited space assets can only add to the fog and friction of the operations. The solution is obvious, but not simple—put up adequate satellites to support *both* theaters.

### Interference with Satellite Operations

In future conflicts, the US cannot afford to assume that our space assets will not be interfered with. Future planners may need to "factor in" satellite attrition, just as ground and air forces attrition is included in today's planning.[25] The former Soviet Union has demonstrated several types of ASAT technology,[26] and it is reasonable to predict that this technology will be available to future aggressor nations.[27] The US strategy of fielding low quantities of high-quality satellites creates "an over-concentration of US assets in a limited number of necessarily costly satellites [which] provides inviting targets, contributing to an increased threat."[28] A satellite will probably not be "taken out" by an ASAT weapon unless hostilities are occurring, and the aggressor will probably only target satellites critical to the ongoing conflict. To maintain space support for the war fighter, the satellite would have to be replaced immediately.

### Counterspace Operations

Just as we must ensure US use of space, we must plan to deny that use to any adversary (space control). Certain types of counterspace weapons employed by the US may need to be placed into orbit (or replenished) during hostilities. One of the principles of the Air Force's contribution to national security is that "space superiority is joining air superiority as a *sine qua non* of global reach and power."[29] However, space superiority cannot be achieved unless the US can overcome the operational demands presented above.

## Meeting the Challenges: RASFOR

The challenges facing space systems in the future point to the need for RASFOR as an essential element of future combat forces. Gen John Piotrowski, former commander in chief of USSPACECOM, stated that the US "must be capable of *reconstituting* degraded or destroyed spacecraft *on demand*" (emphasis added).[30] Our current launch tools can meet peacetime requirements, but they are "much too slow to meet the demands of combat."[31]

### A Proven and Recognized Solution

The use of RASFOR was clearly demonstrated during the Falklands War. Within a 69-day period of the war, the Soviet Union conducted 29 satellite launches—an extraordinary surge capability.[32] In contrast, US emergency launch times must be measured in months rather than days. As an example, consider the failure of a DMSP satellite on 3 September 1987. On 13 October 1987, an emergency launch call was issued; a DMSP replacement was "urgently needed." The replacement satellite was launched 3 February 1988—113 days after the emergency call, 153 days after the failure.[33]

In the future, it is likely that a major regional conflict can be fought and won (or lost) in much less than 153 days.[34] Recognizing this shortfall in combat support capabilities, the Army and the Navy have actively pursued the development of launch systems that field commanders could use. The proposed Army system would use lightsats to be launched "on demand by theater commanders."[35] A similar program has been proposed by the Navy—the sea launch and recovery (SEALAR) system. SEALAR would allow lightsats to be launched from ships or from the ocean surface.[36] Even though these tactical launch systems may never be procured, the Army and Navy clearly consider RASFOR an important solution to future combat requirements for space.

### Other Solutions

RASFOR is one solution to the challenges faced by future space systems, but it is not the only solution. Space support tasks can be accomplished by simply maintaining the status quo launch replacement methods, by using on-orbit spares, or by repositioning existing satellites. However, from the war

fighter's perspective, even though RASFOR is not the *only* solution, it is the *best* solution.

The least attractive alternative is to keep things as they are. In war-fighting terms, this means that we must cross our fingers and hope that future adversaries give us as much lead time as Saddam Hussein did, and that they have no space force to challenge us. This, however, is not likely.

During Desert Storm, a military satellite was moved from Pacific Ocean coverage to Indian Ocean coverage to augment communications capacity in the theater. It was the first time a DOD satellite had been repositioned to support US combat operations. Although this action fulfilled a combat support requirement, continuing the approach of reconstitution through on-orbit storage and repositioning is flawed.[37]

The concept of the on-orbit storage of spare satellites (prepositioning) makes the spares as vulnerable as the active satellites. Enemy space forces can monitor and selectively target critical satellites and take them out at once. Storing spare satellites on orbit also uses up a portion of their useful life through exposure to the harsh space environment and the use of limited expendables such as fuel for station keeping. Repositioning maneuvers also expend limited fuel resources; in certain cases, the required orbital changes may be so great and the available fuel so limited that the repositioning maneuver is not physically possible. Further, when a satellite is moved to a new area, it will weaken (or eliminate) the support in the old area. Finally, repositioning is not an instantaneous event. If a responsive spacelift capability is available, there may be certain cases when it would take less time to launch a new satellite (using RASFOR) than it would to reposition an existing one.

## Summary

Future conflicts will require more responsive military forces which are increasingly dependent on space assets to support their operations. They may be pitted against adversaries who also have military space assets, giving challenge to our space systems during military operations. The proliferation of space technology may allow future adversaries to degrade or destroy our satellites. Also, unanticipated system failures and multiple area coverage requirements may require the immediate placement of satellites into orbit. To meet these challenges, RASFOR is essential to space operations—it can provide the space support tasks necessary to meet joint requirements in the future combat environment. Although alternative operational concepts exist (status quo launch, on-orbit storage, and repositioning), they are inferior to RASFOR. Despite the mandate for RASFOR, the capability does not exist; the reasons for this are examined in chapter 3.

## Notes

1. *Global Reach—Global Power, The Evolving Air Force Contribution to National Security* (Washington, D.C.: Department of the Air Force, December 1992), 4.

2. Lt Gen Thomas S. Moorman, Jr., USAF, "Space: A New Strategic Frontier," in *The Future of Air Power in the Aftermath of the Gulf War,* ed. Richard H. Schultz, Jr., and Robert L. Pfaltzgraff, Jr. (Maxwell AFB, Ala.: Air University Press, July 1992), 238.

3. Ibid., 236.

4. Vice Adm William A. Dougherty, "Storm from Space," U.S. Naval Institute *Proceedings* 118, no. 8 (August 1992): 48.

5. Ibid.

6. Moorman, 241.

7. Robert L. Pfaltzgraff, Jr., "The United States as an Aerospace Power in the Emerging Security Environment," in *The Future of Air Power in the Aftermath of the Gulf War*, 47.

8. Lt Gen Glenn A. Kent, USAF, Retired, "The Relevance of High-Intensity Operations," in *The Future of Air Power in the Aftermath of the Gulf War,* 132.

9. Moorman, 243. Other references state that space assets provided 90 percent of these communications.

10. Briefing, Deputy for Non-Proliferation Policy, International Security Affairs, Office of Secretary of Defense, Washington, D.C., subject: Proliferation of Space Technology, 18 October 1991, 18.

11. Peter Anson, BT, and Dennis Cummings, "The First Space War: The Contribution of Satellites to the Gulf War," *RUSI Journal* 136, no. 4 (Winter 1991): 49. In addition to the SPOT (France) and LANDSAT (US) systems, the following satellites were used: for meteorological data, GOES (US), NOAA (US), and METEOR (USSR); for oceanographical data, OKEAN (USSR); and for Earth observation, RESUR-F (USSR) and RESURS-O (USSR).

12. Moorman, 244.

13. *National Military Strategy of the United States* (Washington, D.C.: The Pentagon, January 1992), 23. The recent Bottom-Up Review was conducted by DOD in accordance with the following strategy: it focused on two hypothetical major regional conflicts, with the aggressors being (1) a remilitarized Iraq, and (2) North Korea. Both scenarios were characterized by short lead times, with the aggressors pursuing combined-arms offensives against the outnumbered forces of a neighboring state. The scenarios were used to evaluate the projected performance of US forces in relation to critical parameters such as warning time, the threat, terrain, weather, duration of hostilities, and combat intensity.

14. Les Aspin, *The Bottom-Up Review: Forces for a New Era* (Washington, D.C.: Department of Defense, 1 September 1993), 24–25.

15. John D. Morrocco, "US Uses Gulf War to Frame New Strategy," *Aviation Week & Space Technology* 140, no. 3 (17 January 1994): 40.

16. Moorman, 237.

17. David A. Fulghum, "Talon Lance Gives Aircrews Timely Intelligence from Space," *Aviation Week & Space Technology* 139, no. 8 (23 August 1993): 70.

18. Maj Gary D. Burg and Maj Gus Liby, "The Military-Technical Revolution: A Doctrinal Challenge," Air Command and Staff College notes, Maxwell AFB, Ala., Air University, 1993, 8.

19. Quoted in Marc J. Berkowitz, "Future U.S. Security Hinges On Dominant Role in Space," *Signal* 46, no. 9 (May 1992): 73.

20. Christopher D. Lay, "Space Control Predominates as Multipolar Access Grows," *Signal* 44, no. 10 (June 1990): 77.

21. Briefing, Proliferation of Space Technology, 26–27, 59–60. The required system resolution for event detection is in the 10–20 meter range. The capability of detection would still be present even if all US and allied systems were removed from access. The systems listed as the most problematic are the ALMAZ (Russian) and RADARSAT (Canadian) systems, since they have day/night and all-weather capabilities.

22. F. Peter Wigginton, "US Allows Sale of Satellite Services, Systems," Columbus, Ohio: American Forces Information Service via CompuServ Information Service, 10 March 1994. On 9 March 1994, President Clinton signed a presidential decision directive that reversed national

policy to allow US companies to sell satellite technologies and systems to foreign consumers. Each sale must be approved by the State Department, and restrictions are placed on the transactions: no satellite transmission can be scrambled in a way that the US government can't decipher; US government retains right to shut down satellite systems based on national security concerns. However, some intelligence, defense, and commerce officials expressed concern that "the capability could one day be turned against the United States."

23. Ibid., 44–45.

24. Ibid., 49–50. In addition to the "traditional space nations" (US, France, China, Russia), these countries include Brazil, Korea, India, Iraq, Israel, Pakistan, and South Africa.

25. Lay, 78. The ASAT threat is not limited to the destruction of space assets. Lay says there are "many methods that can be used to degrade or disable a spacecraft. Some disabling methods cannot be detected until the satellite is put to use."

26. *Soviet Military Power Prospects for Change 1989* (Washington, D.C.: Government Printing Office, 1989), 55–56.

27. James T. Hackett and Dr Robin Ranger, "Proliferating Satellites Drive U.S. ASAT Need," *Signal* 44, no. 9 (May 1990): 155.

28. Ibid.

29. *Global Reach—Global Power,* 8.

30. Gen John L. Piotrowski, "The Right Space Tools," *Military Forum* 5, no. 5 (March 1989): 46.

31. Ibid., 44.

32. Lt Col Stephen J. Dunning, *U.S. Military Space Strategy* (Newport, R.I.: The United States Naval War College, 14 May 1990), 9.

33. Gen John L. Piotrowski, address to the Michigan State Air Force Association Convention, East Lansing, Mich., 28 July 1989.

34. Morrocco, 40. The author notes that Desert Storm was conducted within a time frame in which "coalition forces were allowed to build up their forces unmolested, a luxury the US cannot rely upon in the future."

35. Col Norman W. Styer, Jr., and R. C. Ferra, "Space-Based $C^3$I Is Critical to Future Contingence Army," *Army* 40, no. 4 (April 1990): 44.

36. "Soaring Navy Satellites Improve Sea Operations," *Signal* 45, no. 10 (June 1991): 47–48. Prototype development and limited testing have been accomplished on the SEALAR system.

37. Moorman, 244. General Moorman noted that, although this event illustrated the flexibility of some of our military satellites, "this feat nevertheless highlighted our need to be able to more rapidly augment our on-orbit capabilities."

## Chapter 3

# The Realities

*Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur.*

—Giulio Douhet

The national mandate for rapid space force reconstitution (RASFOR) has been discussed in two ways: chapter 1 addressed the top-down approach and chapter 2 examined the bottom-up requirements. Both chapters clearly show that the mandate for RASFOR exists, but they failed to address a key question: *If there is such a mandate—why hasn't RASFOR been developed?* The answer to this lies in an examination of our nation's existing space support structure and the forces that shaped it. This chapter discusses the *realities* that have prevented the recognition and pursuit of the RASFOR mandate. This discussion includes a look at the *history* of spacelift and satellite development, at the *requirements* and the *politics* which have shaped the course of this development, and at perceived myths with the *implementation* of a RASFOR system.

## History

One of the major problems with our current space launch vehicles (SLV) is that most of them are derivatives of ballistic missiles—they were never designed to deliver satellites to orbit. For the most part, these SLVs are based on 30- to 40-year-old technology.[1] These ICBM core vehicles evolved over the years, primarily in response to growing payload requirements.[2] The expense of spacelift helped to fuel a vicious cycle for satellite design. First, high development and launch costs led to the procurement of high-quality (and long-life) satellites in low quantities. In turn, the requirement for long satellite life led to numerous reliability design features, including subsystem redundancies, that added complexity and weight to the satellite. This added weight required more performance from the SLV, which in turn drove up the spacelift costs. The increased spacelift cost brings us full circle back to the need for high-quality satellites.

Although the booster community delivered incremental performance increases for their satellite customers, today's SLVs have only undergone one, possibly two, generations of evolution since the late 1950s. In contrast, jet fighter aircraft have undergone five generations from the F-86 to the F-22,[3]

and stealth technology has also undergone five generations.[4] General Moorman stated that "the space community is launching the equivalent of the F-4 series fighter into space" and advised that "space launchers need the same relative modernization that our modern-day fighters have had."[5] There has never been a "clean sheet" design for an operational military SLV; in fact, the Saturn V and the Space Shuttle represent the only US spacelift vehicles designed "from scratch."[6]

In addition to their ever-increasing performance requirements, the satellite community has also made demands on the physical configuration of the boosters. Payload interfaces, shrouds, and pyrotechnic devices have at times varied greatly from launch to launch. Since these engineering changes can only be flight-validated during an actual launch, many SLV flights become research and development (R&D) milestones.[7]

This R&D approach often resembles the 1950s B-movies, where space launches are performed by groups of scientists in white lab coats. It is in sharp contrast to the normal concept of military operations, in which the standardization of training and procedures is paramount. There is limited standardization in the assembly and checkout of boosters, and even less during payload processing.[8] In many cases, special test and support equipment is required for launch preparations. Personnel training is also a challenge, because the procedures on which an operator becomes qualified on one launch may change for the next launch.

This R&D approach to spacelift has at least four negative operational impacts: reduced error margin, increased support requirements, increased processing times, and increased operating costs. The R&D methodology often pushes the design limits of the vehicle, thus reducing its margin for error.[9] New "black boxes" and increased thrust requirements may put vehicles at the edge of their performance capabilities, making each launch very risky. To help reduce this risk, an elaborate vehicle processing support network is used. This network often requires unique test equipment and procedures, and it is usually manned by an army of contractor engineers and technicians. In addition, a contingent of government workers is required to plan and monitor the processing. This methodical, "check everything twice" approach may reduce risk, but it does so at great cost to schedule. Procedures written at a contractor's facility may not work at the launch pad, making "redlines" and workarounds common. Lack of standard test software also contributes to increased processing times. These items—unique support equipment and procedures, highly qualified personnel, and long processing schedules—result in high operating costs for each launch.

## Requirements

The primary reason the US has not pursued RASFOR has its roots in the US design approach to spacecraft. Unlike the former Soviet Union (FSU), the US has always stressed *quality* over *quantity*. US satellites are designed to

have long service lives, the strategy being to *endure;* the FSU strategy has been to *surge,* using its robust spacelift capability. US satellites are also designed to be more capable, which required the FSU to have more satellites in their constellations to do the same job. The resulting high satellite replacement rate forced the FSU to develop a spacelift infrastructure capable of launching five times more frequently than the US.[10] Historically, many US satellites' lives exceed prediction, thereby allowing a launch-on-schedule strategy to build up assets in space.[11] Because of this, there has been no drive to make RASFOR a reality.

Another key reason why RASFOR has not been pursued is the *perceived* lack of a credible threat to US space systems. As discussed in the previous chapter, the US military has become dependent on the force enhancements provided by space systems.[12] This dependency on space assets is a vulnerability that a competent foe can't afford to ignore. Even though this vulnerability exists, two popular perceptions preclude its serious consideration: (1) international law prohibits space weaponry and (2) no country possesses a credible space warfare capability. Both of these perceptions are false.

Let's first consider space law. Although the Outer Space Treaty of 1967 outlaws military operations on the moon and other celestial bodies, and it prohibits weapons of mass destruction in orbit,[13] there is no clear agreement outlawing the deployment of conventional weapons in space.[14] Even if international law did prohibit all space weaponry, it would provide no guarantee against an aggressor country actually developing and using such systems. A lesson from history illustrates this. In the spring of 1916, Germany forswore unrestricted submarine warfare for the second time in World War I. However, by April 1917, German submarines were sinking one out of every four ships that left England.[15] This lesson was not learned. Despite the 1936 Protocol Agreement that Great Britain thought would prevent the use of U-boats in commerce raiding, Hitler resorted to unrestricted submarine warfare in 1940.[16] It is reasonable to assume that any country which decides to attack the US may elect not to "play by the rules."[17]

Are there any countries that can pose a threat in space? Absolutely. Not including those countries with established space programs (US, FSU, France, Japan, China), there are at least 22 countries with active ballistic missile programs, nine of which are also pursuing SLV capabilities.[18] The emergence of space warfare capabilities by other countries seems not to be "if," but rather "when." The key space threat still resides in the FSU: Russia! Russia has retained 90 percent of the FSU space industry, including two of the three launch complexes.[19] However, a capability does not equal a threat; hostile intentions must also be demonstrated. For this, let us look at Russian military doctrine. One of the seven priorities of the Russian Armed Forces is *military space systems,* and achieving *space superiority* is listed as a prerequisite for the use of ground troops in a conflict.[20] Also, remember that Russia is still experiencing some political instability. If radical leaders such as Vladimir Zhirinovsky were to come to power, the threat would increase.[21]

Even though the perception of no credible space threat is unfounded, it has still contributed to retarding the development of RASFOR.

What RASFOR development needs is a good crisis! Although this is certainly not the preferred way of doing business, it may be the only way that the necessary attention will be directed at the mandate. In the past, the US has often waited until it perceived a *severe* threat—a crisis—before it acted. The resulting actions involved sudden major investment and effort to overcome the threat. To accomplish this de facto strategy, the US relies heavily on technological surges rather than consistent and incremental improvements.[22]

Simply put, US spacelift has not been put to the war-fighting test yet. Although US forces relied upon satellite-based force enhancement during the Gulf War, there was never a threat that required rapid satellite reconstitution. Of the four combat media—land, sea, air, and space—only in space has the US consciously decided not to pursue critical space control and force application capabilities. Maj Gen Robert Rankine, former vice-commander of Air Force Space Division, stated that "our capability to accomplish *force enhancement* from space is superior to that of the Soviets—but only during hostilities that do not place the satellites themselves under attack."[23] Another senior DOD official noted that "the Soviet Union is superior in the warfighting aspects of the launch infrastructure."[24] Since there has been no need for the rapid reconstitution of satellites in combat, there has been no effort toward RASFOR development.

## Politics

To meet the operational mandate discussed in the previous chapter, a military RASFOR system must be able to project combat resources into space rapidly during a conflict. This capability is in direct violation of the sanctuary doctrine, a school of thought advocated by many at the highest levels of government.[25] These advocates argue that space systems have had a stabilizing influence on superpower relations through the use of "national technical means of treaty verification" to verify arms treaties. They feel that the only way to maintain the legal overflight status ("open skies" policy) is to designate space as a war-free sanctuary.[26] Although this doctrine represents an admirable ideal, in reality it is not valid. It is inconceivable that opposing nations would accept the force-multiplying effects of satellites on terrestrial wars and still allow space to remain a benign area. Satellites have been used extensively in combat already, and "like lost virginity, the [lost] ideal sanctuary is irretrievable."[27]

One of the political challenges facing RASFOR is that the development of its spacelift element may require the consensus of numerous space agencies. This process, which is difficult even within individual agencies, is

time consuming, and it often forces unfavorable compromises. A review of the decision-making process during the Space Shuttle development noted:

> While one of the long-term strengths of the American system has been a willingness to make pragmatic compromises to achieve results acceptable to the widest range of viewpoints, in a heavily technological arena such an approach was of questionable virtue.[28]

Indeed, the topic of spacelift has been over-studied since the *Challenger* disaster, with no consistent national launch strategy being developed, let alone a definite decision to pursue the rapid-response spacelift capability required for RASFOR.

With ever-tightening federal budgets, funding is another difficult hurdle for RASFOR development. With the demise of the FSU, many Americans expect a "peace dividend" to be spent internally—on domestic instead of defense programs. The willingness to invest in future technology is not there; "the American political process, perhaps with Project Apollo excepted, is ill-suited to technological programs whose payoffs come only in future decades."[29] However, we always seem to have enough money to pay for our past mistakes. A recent editorial in *Space News* noted, "The problem [with DOD launch strategy] is that the space shuttle and Titan are soaking up all the money, leaving nothing for vehicles that would replace them."[30]

While a detailed case study of the space shuttle, or space transportation system (STS), is beyond the scope of this paper, a brief review of some of its political problems is germane to RASFOR. After all, the STS was originally conceived as a rapid-response spacelift system capable of two-week flight turnarounds and 25 or more missions per year using five reusable orbiters.[31] However, after running through numerous political wickets, the final product bore little resemblance to the original concept.

When funds were reduced under the Nixon administration, NASA tried to gain support "on cost-effective, rather than on scientific, technological, or other grounds."[32] This strategy was a mistake made by "government bureaucrats who played the political game and sold the Shuttle as an inexpensive program, in the process sowing the seeds of disaster."[33] During development, the STS was kept alive through a forced marriage between NASA and DOD (mandated by President Carter). This arrangement forced a dramatic change in STS configuration and mission profile that, in turn, increased program costs.[34] It also resulted in sole reliance on the STS for US heavy spacelift—the US had all of its space-access eggs in one basket. The spacelift crisis resulting from the *Challenger* accident led to the rapid reinstatement and modification of four classes of expendable SLVs.[35] The final assessment of the STS, made by the Vice President's Space Policy Advisory Board in November 1992, was that "the Shuttle is very expensive relative to its role in the US space program." This expense is listed at about $5 billion per year to support only seven or eight flights per year[36]—over $700 million per flight (many analysts list this cost even higher). The cost of the most expensive of the "crisis response" replacement SLV programs (the Titan IV) is listed as at least $350 million per launch.[37]

## Myths Concerning RASFOR Development

Developing and implementing RASFOR systems will not be cheap, but these systems can help to lower spacelift costs. By nature of its requirements, the rapid-response spacelift element will have increased reliability to avoid costly losses such as the Titan IV accident discussed in chapter 1. This increased reliability, along with a possible in-flight abort capability, could reduce range safety requirements and costs. Also, a RASFOR system with reduced infrastructure and standardized procedures would have lower operating and manning costs.

Most importantly, RASFOR provides a way to break away from "business as usual" by introducing a fundamental change in the way the US designs satellites. If satellites can be launched rapidly, consistently, and reliably, then the dependence on long-life satellites no longer makes sense. In fact, RASFOR would allow new technology to be implemented faster, since the time between satellite design generations would decrease, and the overbearing emphasis on reliability could be eased. This would result in smaller and more capable systems with shorter lives.[38] This concept will be discussed in more detail in the next chapter.

As discussed in the previous chapter, the FSU demonstrated effective RASFOR during the Falklands War. Their system, previously assumed to be crude by US standards, clearly demonstrates that technology is *not* a barrier to RASFOR development. While existing technologies may suffice, existing systems do not. To approach RASFOR development as the modification of existing SLVs would be a mistake. The entire system—launch vehicle, payload interface, infrastructure, launch operations, personnel, and so forth—must be approached in a "clean slate" manner. Several spacelift systems have RASFOR characteristics; these systems range in maturity from conceptual to operational. But since it is not the purpose of this paper to advocate any specific technical solution, these systems will not be discussed.[39]

Will RASFOR cure all the ills of spacelift? No! Rapid response is not required for all launches—a routine (versus urgent) launch on need should apply to most launches. RASFOR systems may also have payload weight limitations (such as the support equipment needed for manned space flight) that prevent its use for heavy spacelift. To be cost-effective, a separate class of newly designed medium- and heavy-lift SLVs should also be pursued to provide a flexible spacelift capability. RASFOR must be considered as an integral part of a *balanced approach* to military spacelift. It should augment, not replace, current and future spacelift capabilities.

## Summary

There are many reasons why the mandate for RASFOR has not been followed. The historical approach to US spacelift has been through the

progressive modification of ICBM-based SLVs; there has never been a military SLV designed from scratch. The perceived lack of requirements for RASFOR, although a fallacy, has helped to ensure that the mandate be ignored. The previous and current political environments have not been favorable to new technologies that offer no immediate benefits. Technology is not a barrier to RASFOR. In fact, implementation of a RASFOR system may lead to a fundamental change in the way the US designs and deploys satellites. The next chapter will discuss these possibilities in detail.

Credible threats to our satellites exist now within Russia, and many other countries may offer similar threats in the near future. US space forces are *not* unrivaled in their war-fighting capability. Development of a RASFOR system is an *essential* step that the US must accomplish to be the number one power in the "high ground" of combat media.

**Notes**

1. Department of Defense, National Aeronautics and Space Administration, and Department of Energy, *Ten-Year Space Launch Technology Plan* (Washington, D.C., November 1992), ES-1. The current Atlas II SLV is based on the Atlas ICBM; the current Titan IV SLV is based on the Titan ICBM; and the current Delta II is based on the Thor ICBM.

2. Lt Col Randall G. Joslin, *Spacelift—A National Challenge for USSPACECOM,* Air War College Associate Programs research report (Peterson Air Force Base, Colo.: 21 June 1993), 8.

3. Ibid.

4. TSgt Phil Rhodes, "Stealth: What Is It, Really?" *Airman* 35, no. 9 (September 1991): 23. Systems developed in each stealth technology generation include: generation 1—the SR-71 (Blackbird) and B-1B (Lancer); generation 2—F-117A (Stealth Fighter); generation 3—the AGM-129A (Advanced Cruise Missile); generation 4—B-2 (Spirit); and generation 5—F-22 (next generation air superiority fighter).

5. Lt Gen Thomas S. Moorman, Jr., "Space: A New Strategic Frontier," in *The Future of Air Power in the Aftermath of the Gulf War,* ed. Richard H. Schultz, Jr., and Robert L. Pfaltzgraff, Jr. (Maxwell AFB, Ala.: Air University Press, July 1992), 245.

6. Joslin, 12.

7. Ibid., 8.

8. Lt Col James D. Martens, *Building Blocks in Space* (Maxwell AFB, Ala.: Air University Press, April 1990), 10.

9. Philip Kunsberg, "Space Infrastructure," in *Building a Consensus Toward Space: Proceedings of the Air War College 1988 Space Issues Symposium* (Maxwell AFB, Ala.: Air University Press, April 1990): 66.

10. Maj Gen Robert R. Rankine, Jr., "The US Military Is Not Lost in Space," in *Building a Consensus Toward Space*, 47–48, 53–54.

11. *Report of the Defense Science Board 1989 Summer Study on National Space Launch Strategy* (Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, March 1990), 29.

12. Rankine, 47–48.

13. AU-18, *Space Handbook* (Maxwell AFB, Ala.: Air University Press, January 1985), 15-2.

14. John B. Rhinelander, "The Law and Space," in *Building a Consensus Toward Space*, 3–12. Space law also allows for activities on celestial bodies that are in self-defense.

15. Russell F. Weigley, *The American Way of War* (Bloomington, Ind.: Indiana University Press, 1977), 193, 243.

16. Notes, Air Command and Staff College lecture MT 520, subject: Subsurface Warfare, 5 October 1993.

17. Capt B. H. Liddell Hart, *The Real War: 1914–1918* (Boston, Mass.: Little, Brown and Company, 1964), 76. As the author put it, "[in] the transition from a war of government policies into a war of peoples, the indefinite code of military chivalry must be submerged by the primitive instincts let loose by a struggle for existence."

18. Maj Thomas A. Torgerson, *Global Power Through Tactical Flexibility: Rapid Deployable Space Units* (Maxwell AFB, Ala.: Air University Press, June 1994). Table 3 of this publication lists 23 countries (asterisk indicates SLV program): Afghanistan, Algeria, Argentina, Brazil,* China, Cuba, Egypt, India,* Indonesia,* Iran, Iraq,* Israel,* Kuwait, Libya, North Korea, Pakistan,* Saudi Arabia, South Africa,* South Korea,* Syria, Taiwan,* Vietnam, and Yemen.

19. Lt Col Gregory A. Keethler, *The Impact of the Soviet Union's Demise on the US Military Space Program*, Air War College research report (Maxwell AFB, Ala.: Air University, 19 April 1993), 2. Recently, Russia signed an agreement with Kazakhstan to rent the third launch complex at Baikonur for $115 million per year for 20 years (reference Ralph Boulton, "Russia Agrees to Lease Baikonur Space Centre" [Columbus, Ohio: Reuters Information Services, Inc. via CompuServ Information Service, 28 March 1994]). This significant expenditure (considering Russia's current economy) signals that Russia gives great priority to its space program: "The new deal, while it does not guarantee any large cash infusion for Baikonur, will at least establish the status of the base *under Moscow's direct control*" [italics added]. On 20 May 1994, Russia launched its first satellite from the Baikonur launch complex under the agreement with Kazakhstan (Guy Chazan, "Russia Launches Commercial Satellite" [Columbus, Ohio: The United Press International via CompuServ Information Service, 20 May 1994]).

20. Mary C. Fitzgerald, "Russia's New Military Doctrine," *RUSI Journal* 137, no. 5 (October 1992): 44.

21. Vladimir Zhirinovsky has stated: "I say it quite plainly: When I come to power, there will be a dictatorship. I will beat the Americans in space. I will surround the planet with our space stations so that they'll be scared of our space weapons." (Source: "Zhirinovsky's Words," *Montgomery Advertiser,* 6 February 1994, F-1.) While some observers do not regard him to be serious, many informed analysts feel that Zhirinovsky may gain significant power in Russia. "Well before 1996, it is conceivable that this clever demagogue . . . could sharply advance his nationwide political fortunes . . . [he] could conceivably be elected parliamentary Speaker." Dr Albert L. Weeks, "Is There a Zhirinovsky in Russia's Future?" *ROA National Security Report,* February 1994, 150–52.

22. Maj Robert H. Chisholm, *On Space Warfare: Military Strategy for Space Operations* (Maxwell AFB, Ala.: Air University Press, June 1984), 21–22.

23. Rankine, 48.

24. Kunsberg, 69.

25. Lt Col David E. Lupton, *On Space Warfare: A Space Power Doctrine* (Maxwell AFB, Ala.: Air University Press, June 1988), 44.

26. Ibid., 35.

27. Ibid., 60.

28. Roger D. Launius, "Toward an Understanding of the Space Shuttle: A Historiographical Essay," *Air Power History* 39, no.4 (Winter 1992): 6.

29. Ibid.

30. Editorial, "Ignore DoD on Launch Strategy," *Space News* 45, no. 39 (4–10 October 1993): 14.

31. Launius, 7.

32. Ibid., 6.

33. Ibid., 17.

34. Ibid., 8.

35. Rankine, 54.

36. *The Future of the U.S. Space Launch Capability, A Task Group Report,* Vice President's Space Policy Advisory Board, E.C. Aldridge, Jr., chairman, Washington, D.C., November 1992, 21.

37. *Space News* editorial, 14.

38. Chisholm, 22.

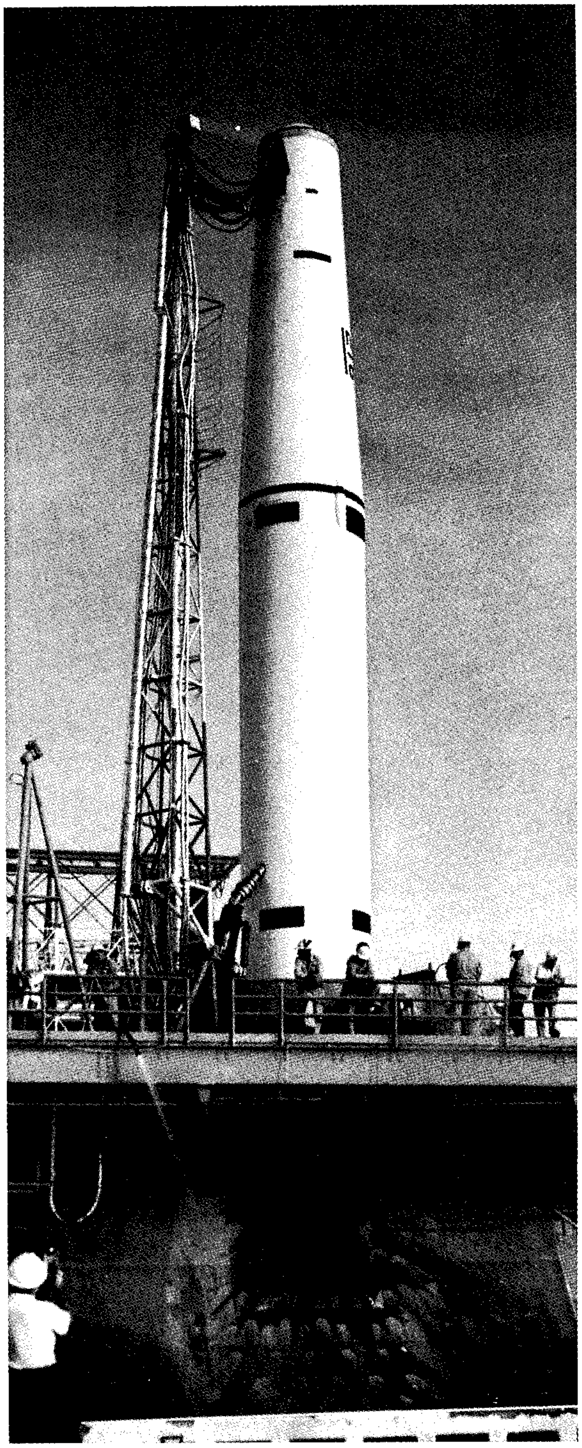
39. Three well-publicized candidates for rapid-response spacelift are the Pegasus, Taurus, and Delta Clipper space launch vehicles. The Orbital Sciences Corporation (OSC) Pegasus is a proven vehicle (first launched 5 April 1990) that can be air-launched from a modified Boeing

B-52 or Lockheed L-1011. "Pegasus Ready to Air-Launch from Stargazer," *Chemical Propulsion Information Agency Bulletin* 20, no. 1 (January 1994): 1, 6. The OSC Taurus vehicle is a ground-launched derivative of the Pegasus; its first launch was from Vandenberg AFB on 13 March 1994. "US Defence Department Launched First Taurus Rocket," Columbus, Ohio: Reuters Information Services, Inc. via CompuServ Information Service, 13 March 1993. Technical details of these vehicles are summarized in: Steven J. Isakowitz, *International Reference Guide to Space Launch Systems* (Washington, D.C.: American Institute of Aeronautics and Astronautics, 1991), 217–30. The McDonnell Douglas DC-X (Delta Clipper) launch vehicle is a test vehicle for single-stage-to-orbit flight. Although the DC-X has not flown into space, it has flown successful hover tests. "DC-X to Fly Again in September," *Aviation Week & Space Technology* 139, no.8 (30 August 1993): 24; and Michael A. Dornheim, "DC-X Makes Second Flight," *Aviation Week & Space Technology* 139, no. 12 (20 September 1993): 39. Also see Dr William A. Gaubatz et al., *A Technology and Operations Assessment of Single Stage Technology Flight Test Program Results*, AIAA Report No. AIAA-93-4163 (Washington, D.C.: American Institute of Aeronautics and Astronautics, September 1993).

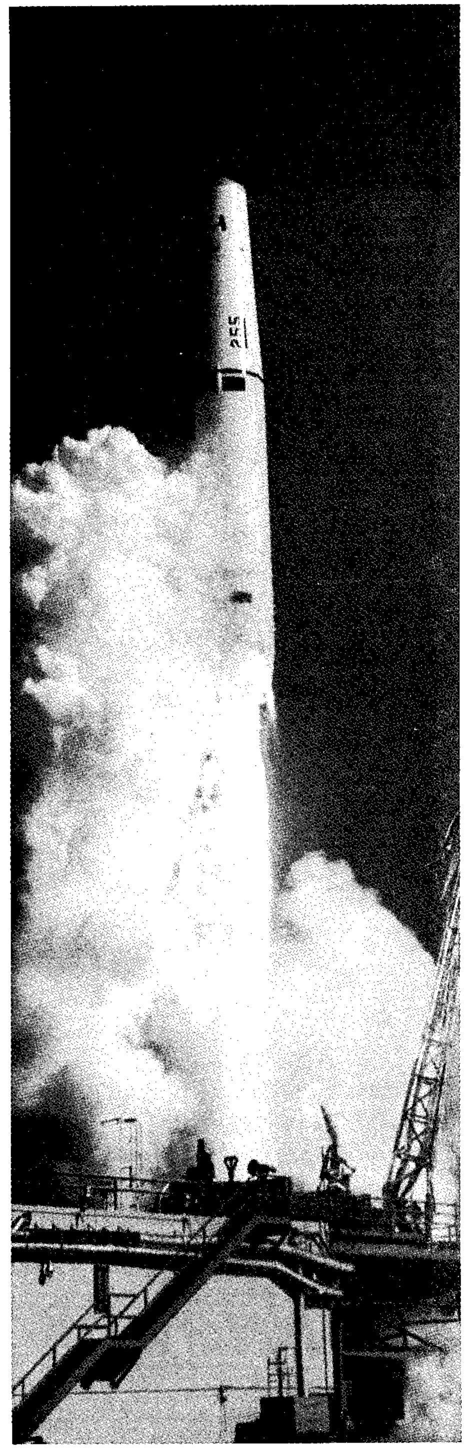
# Photo Section

## A Sampler of US Space Launch Vehicle Heritage

NOTE: Technical details and launch histories referenced in the captions are from Steven J. Isakowitz, *International Reference Guide to Space Launch Systems* (Washington, D.C.: American Institute of Aeronautics and Astronautics, 1991), 183–280; and J. C. Hopkins and Sheldon A. Goldberg, *The Development of Strategic Air Command 1946–1986 (The Fortieth Anniversary History)* (Offutt AFB, Nebr.: Office of the Historian, Strategic Air Command, 1 September 1986).

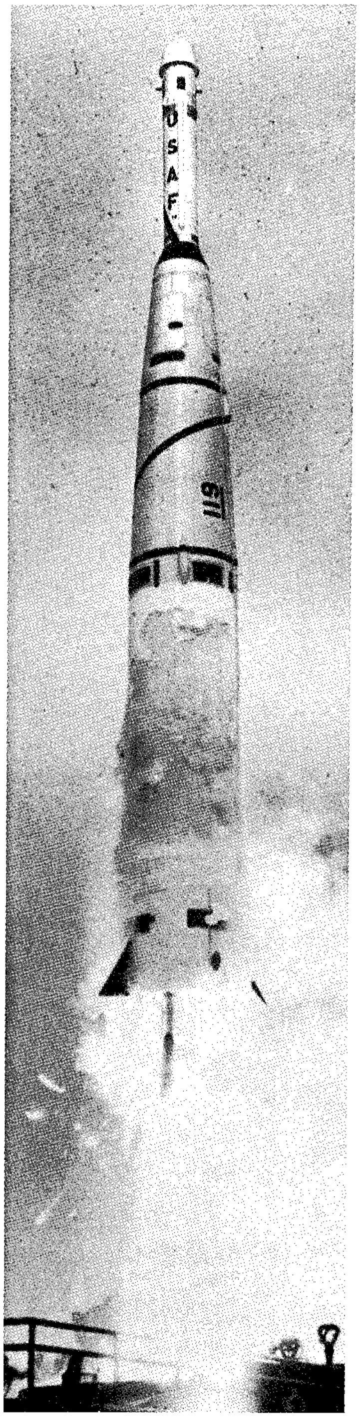


Official USAF photo



Official USAF photo

(Left photo) A Thor space booster (no. 216) sits on pad 17-B at Cape Canaveral on 27 August 1959. (Right photo) A different Thor (no. 255) launches from the same pad on 17 December 1959.



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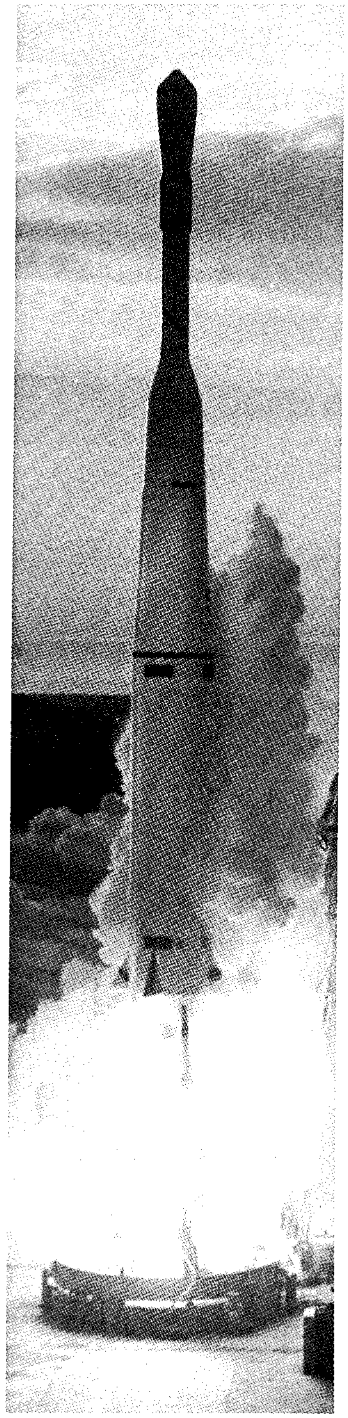

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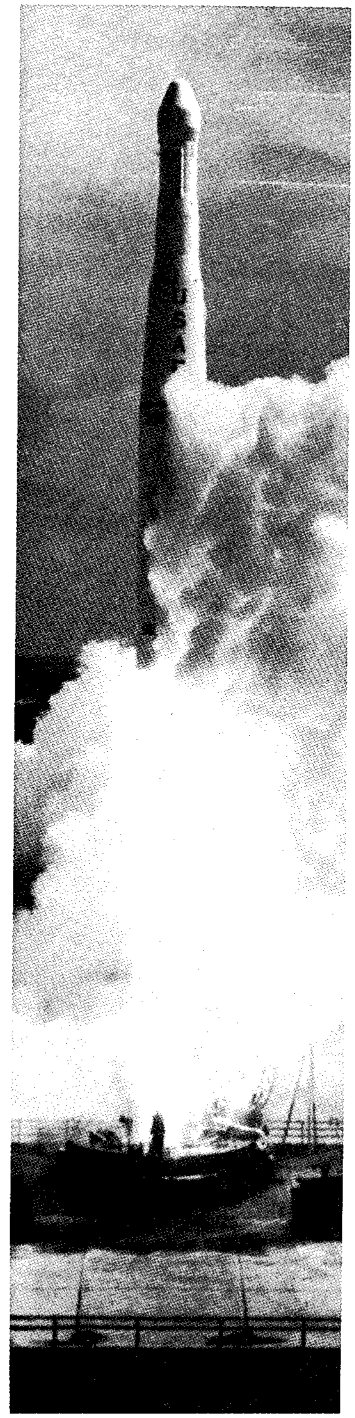
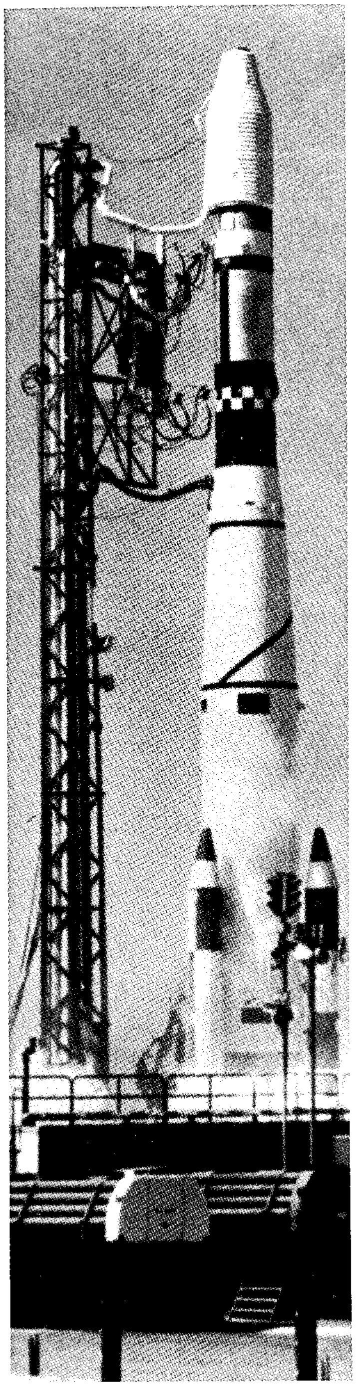


Official USAF photo

The basic Thor modified: Three launches of the USAF Thor-Able space launch vehicle from Cape Canaveral. From left to right, the launch dates were: 23 July 1958, 1 April 1960, and 4 October 1960. This version of the Thor was the forerunner of the first Delta vehicle, which was launched on 13 May 1960.



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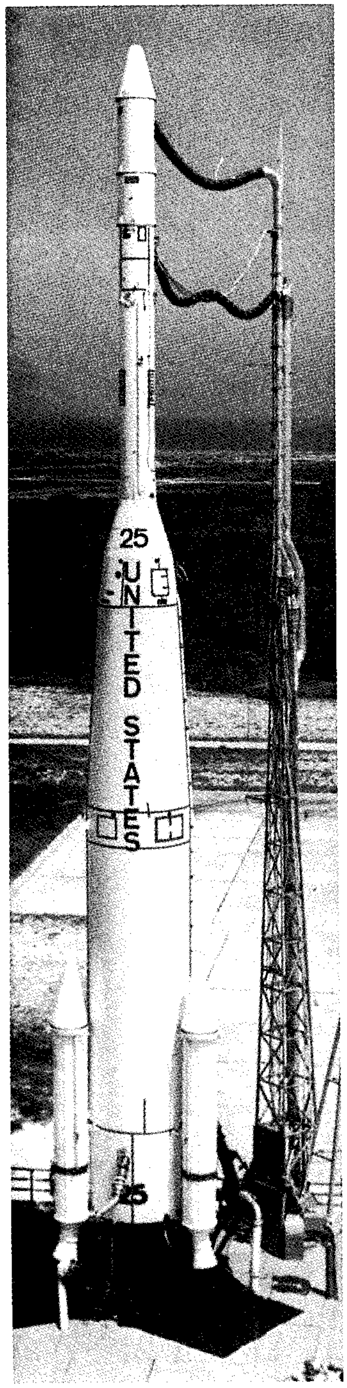
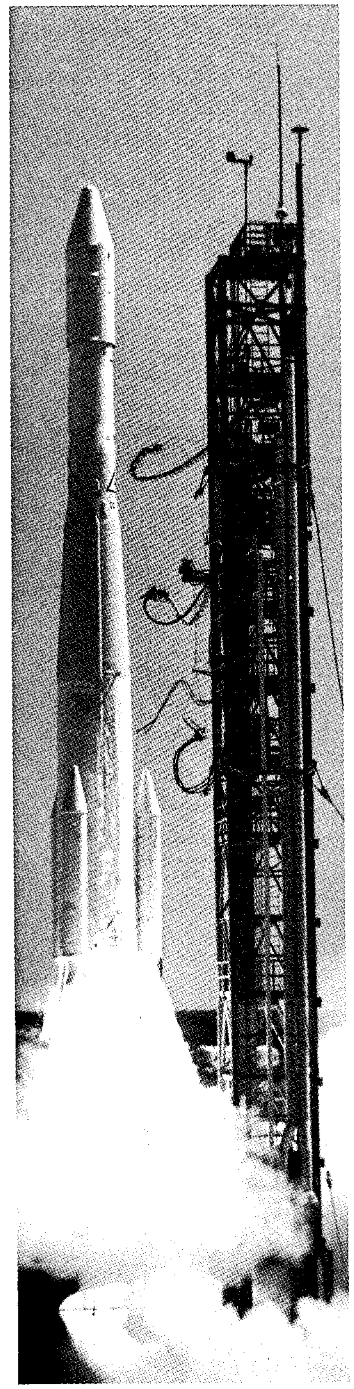
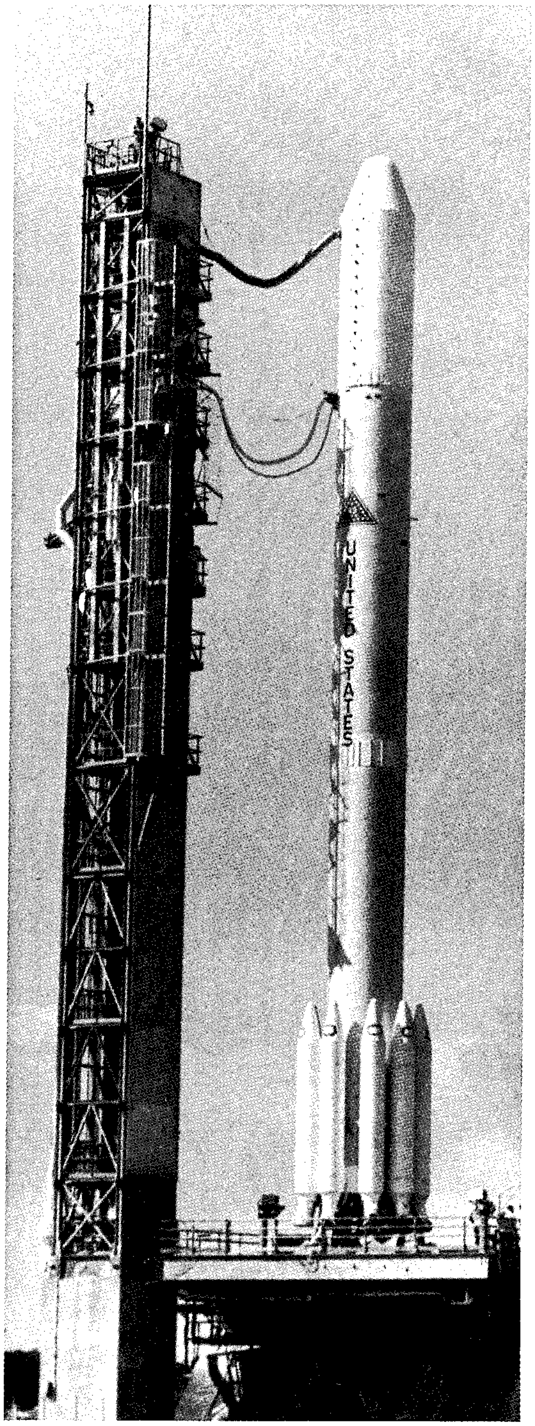



Official NASA photo

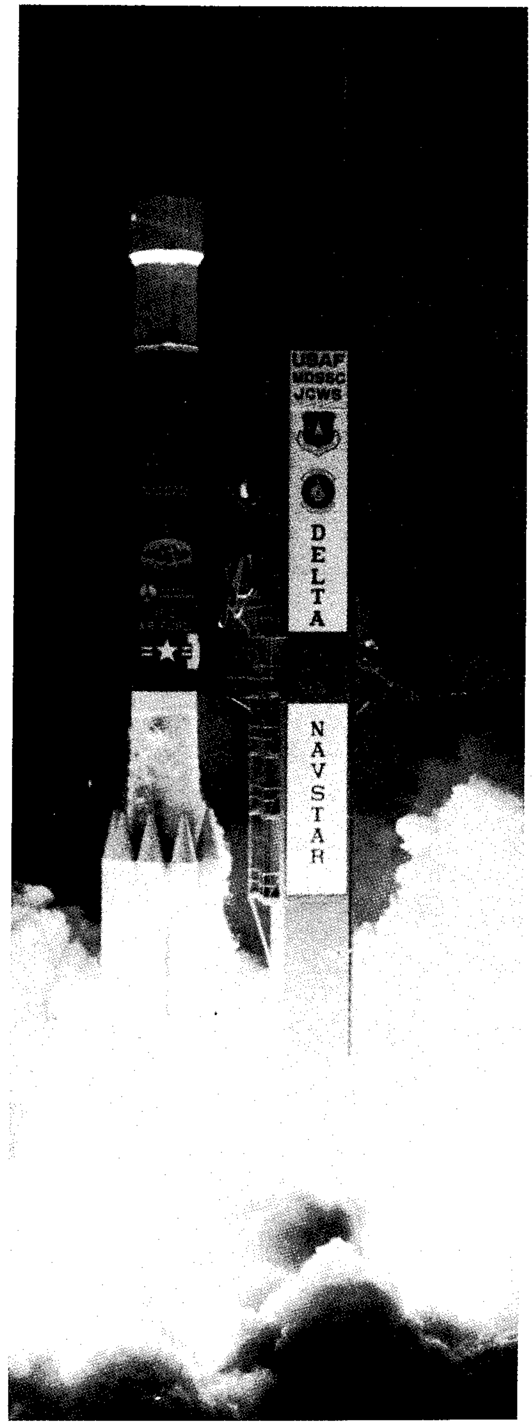


Official NASA photo

Three rocket motors were added to augment the Thor's thrust. (Left photo) A Thor-Agena at Vandenberg AFB, circa 1963. (Center photo) The first NASA Delta D at Cape Canaveral (launch date 19 August 1964). (Right photo) A NASA Delta E launches from Cape Canaveral on 17 August 1966. Four configurations of NASA three-booster Deltas were launched between 1964 and 1971.

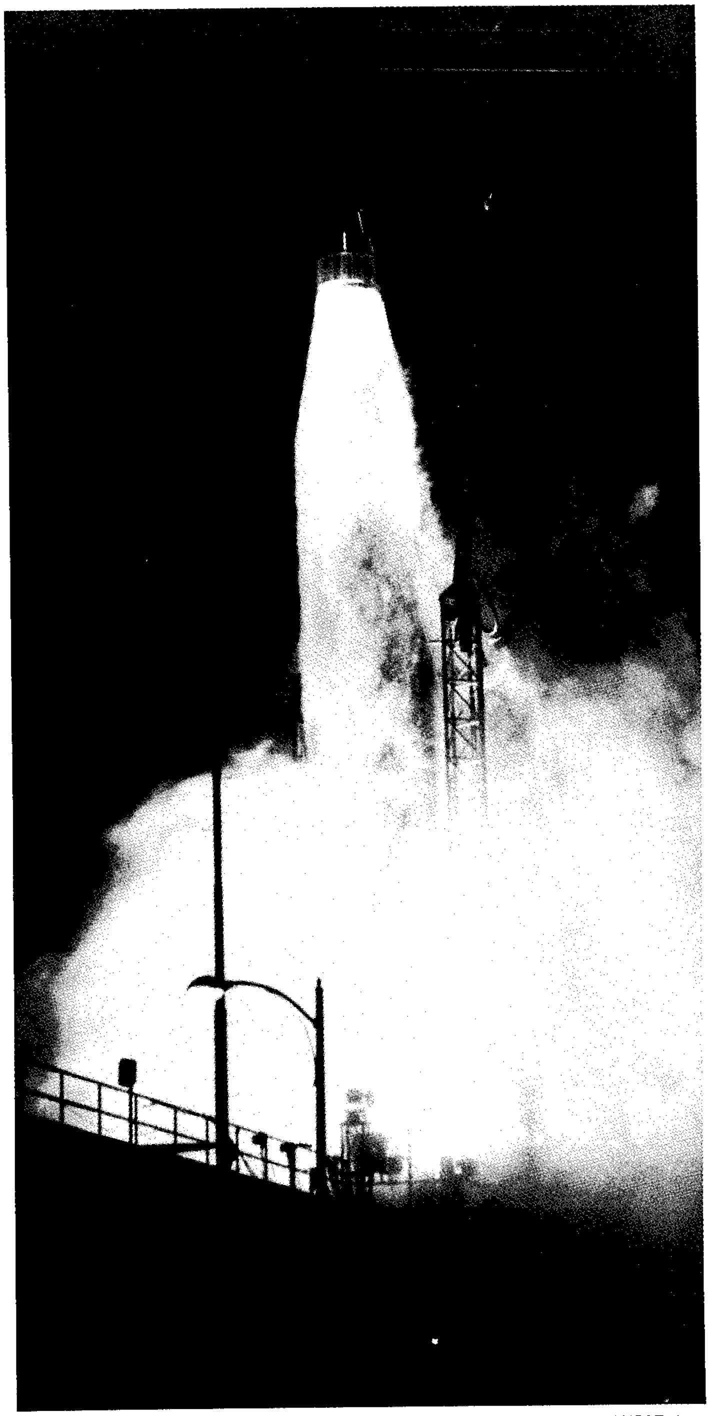



Official NASA photo




Official USAF photo

(Left photo) A NASA Delta 92 vehicle with nine solid rocket boosters at Cape Canaveral. It was launched 10 November 1972. (Right photo) An Air Force Delta II launches a NAVSTAR GPS satellite on 18 December 1992. Between 1960 and 1990, the Delta vehicle underwent over 42 major modifications.



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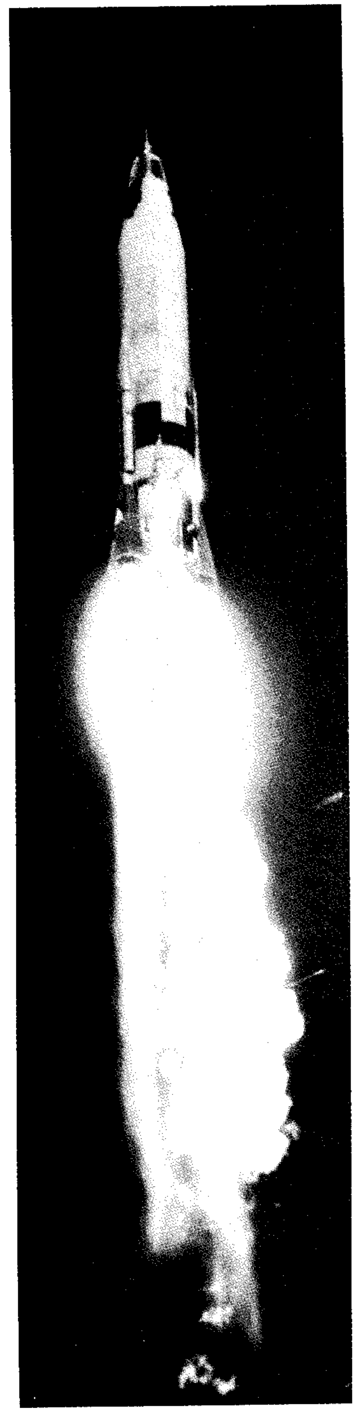
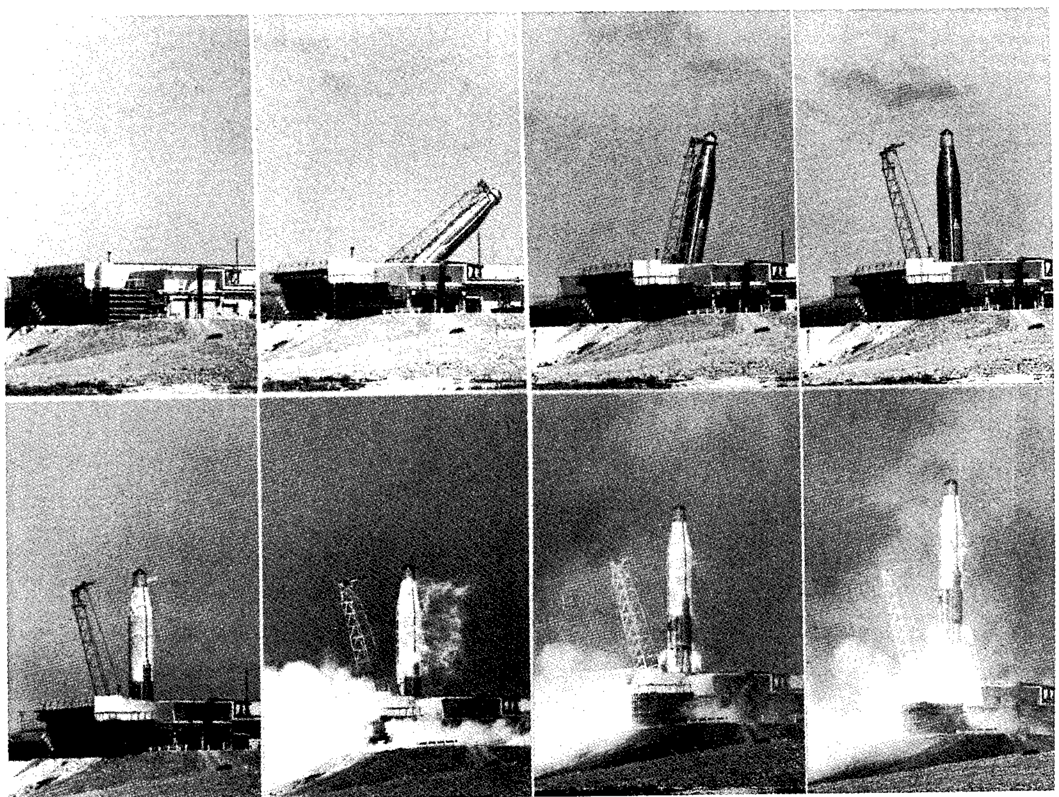


Official USAF photo

(Left photo) An Atlas test missile launches from Cape Canaveral on 18 December 1958. Its flight successfully demonstrated the Atlas's ability to orbit satellites. (Right photo) The first operational launch of an Atlas ICBM by Strategic Air Command, Vandenberg AFB, 9 September 1959.

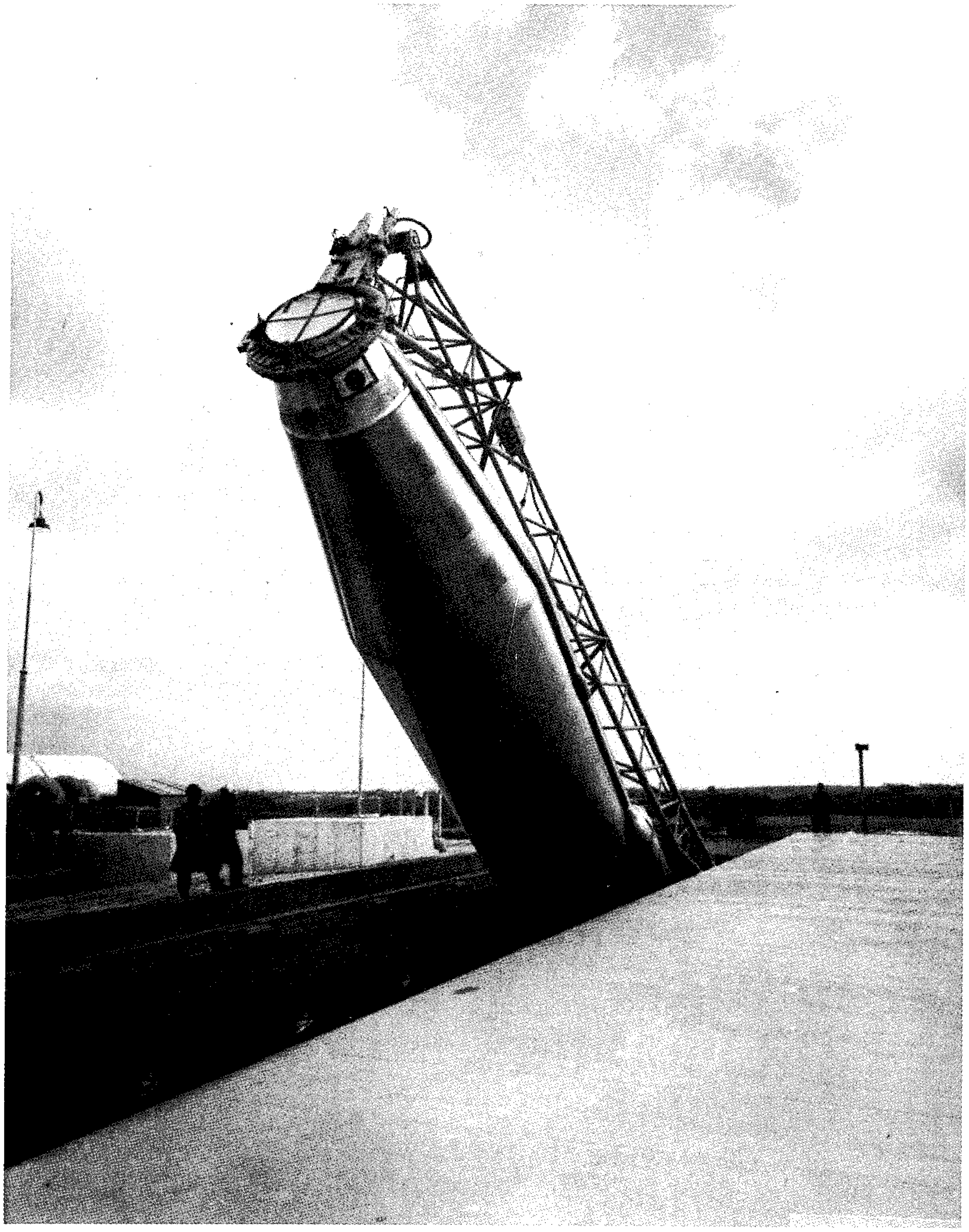
Official USAF photo

They all look the same here! Deactivated Atlas ICBMs sit in storage at Norton AFB awaiting use in space launches. Some of these boosters were also used in the advanced Ballistic Reentry System (ABRES) program from 1965 to 1974.



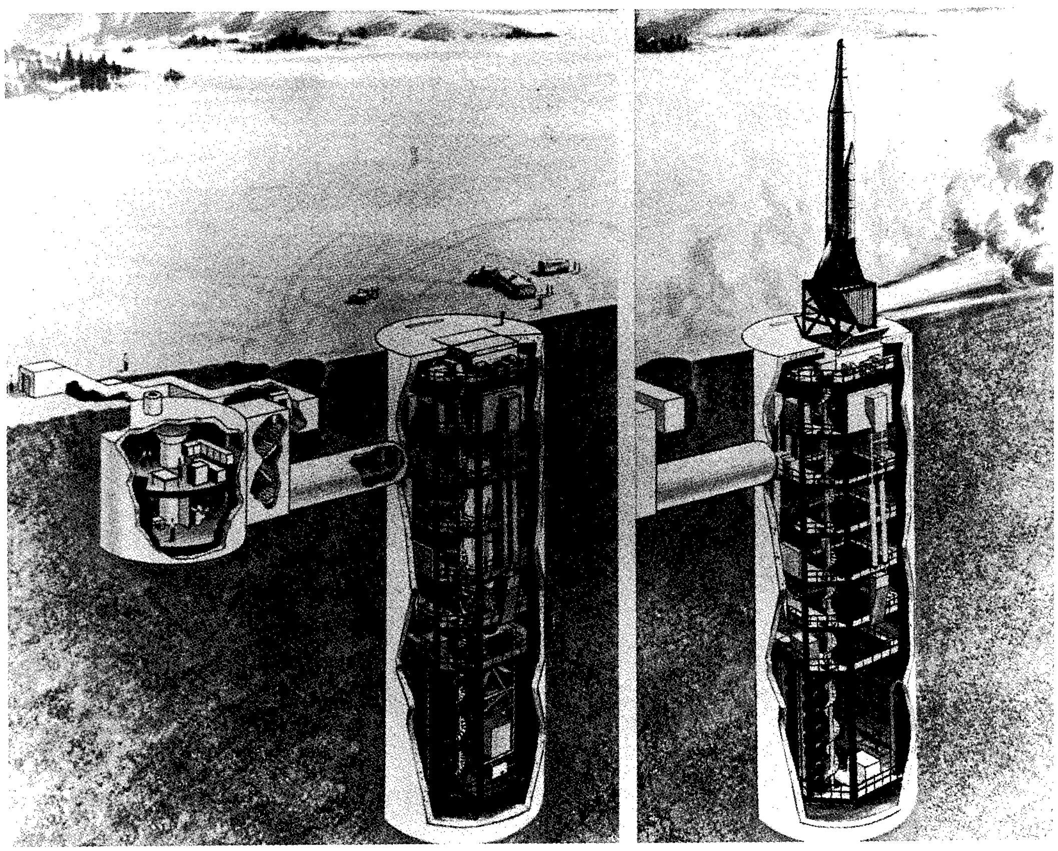
Official USAF photo

An Atlas ICBM is erected, fueled, and launched during the 15-minute period depicted by these eight photographs (circa 1962). This method was often referred to as a “coffin” launch.

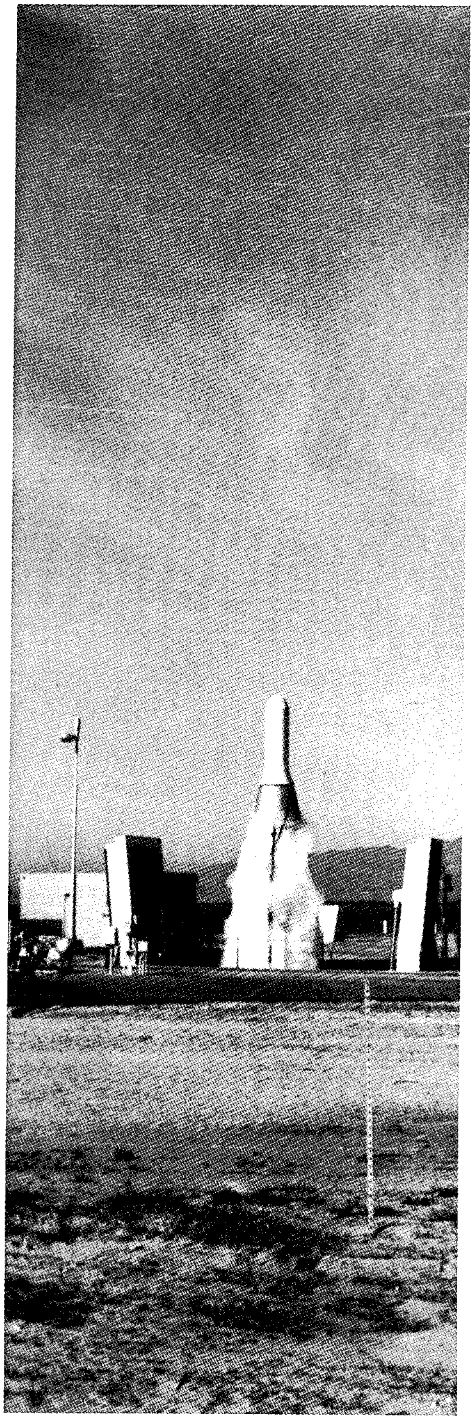


Official USAF photo

An Atlas E model in its launcher at Forbes AFB, Kansas, circa 1961. Shortly after this photo was taken, the facility was turned over by Air Force Systems Command to Strategic Air Command.


Official USAF photo

A cutaway artist's concept of an Atlas F hardened launcher, circa 1960. In this configuration, the Atlas is maintained and fueled vertically in a steel and concrete silo, and then raised by elevator to the surface for firing.



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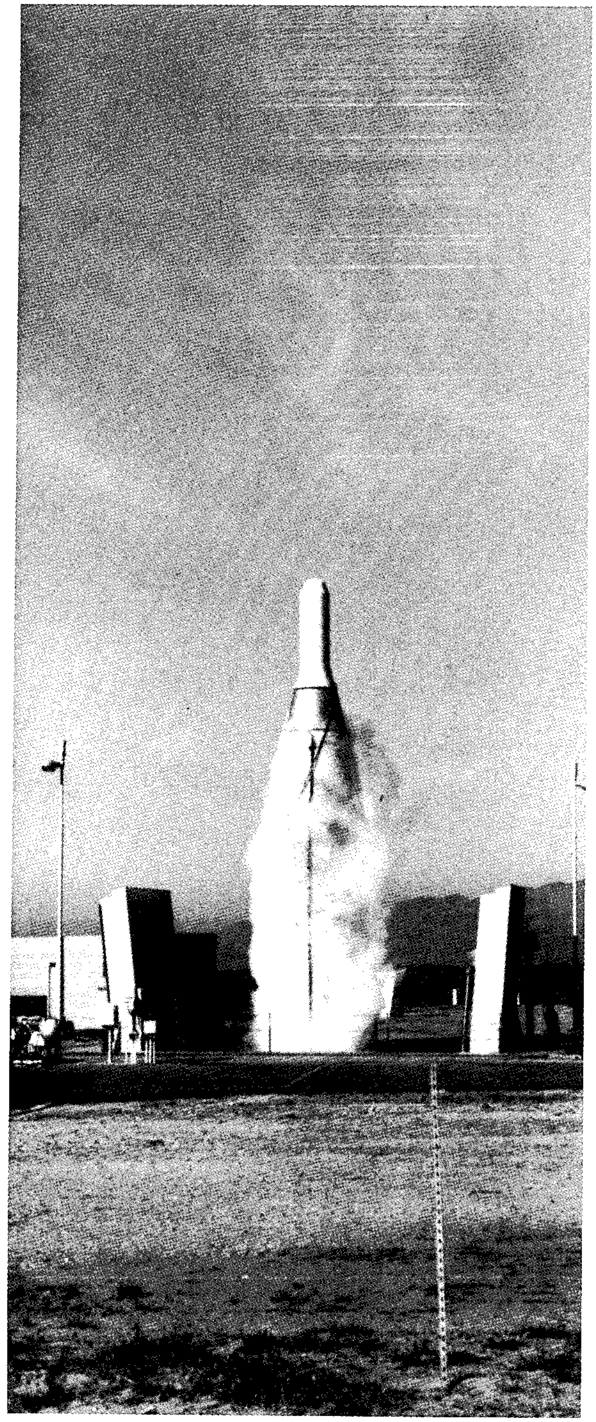
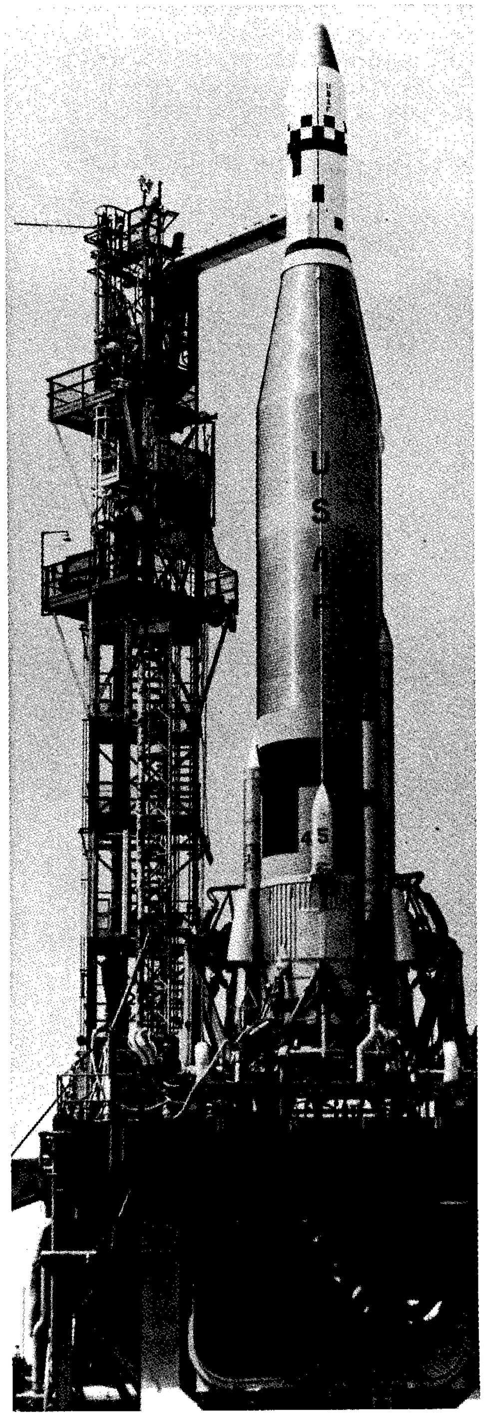


Official USAF photo

An Atlas F is brought to the surface of its launch facility at Vandenberg AFB, circa 1962. Once on the surface, the missile can be launched. The gas surrounding the missile is liquid oxygen (which Atlas uses as an oxidizer) that has vaporized.



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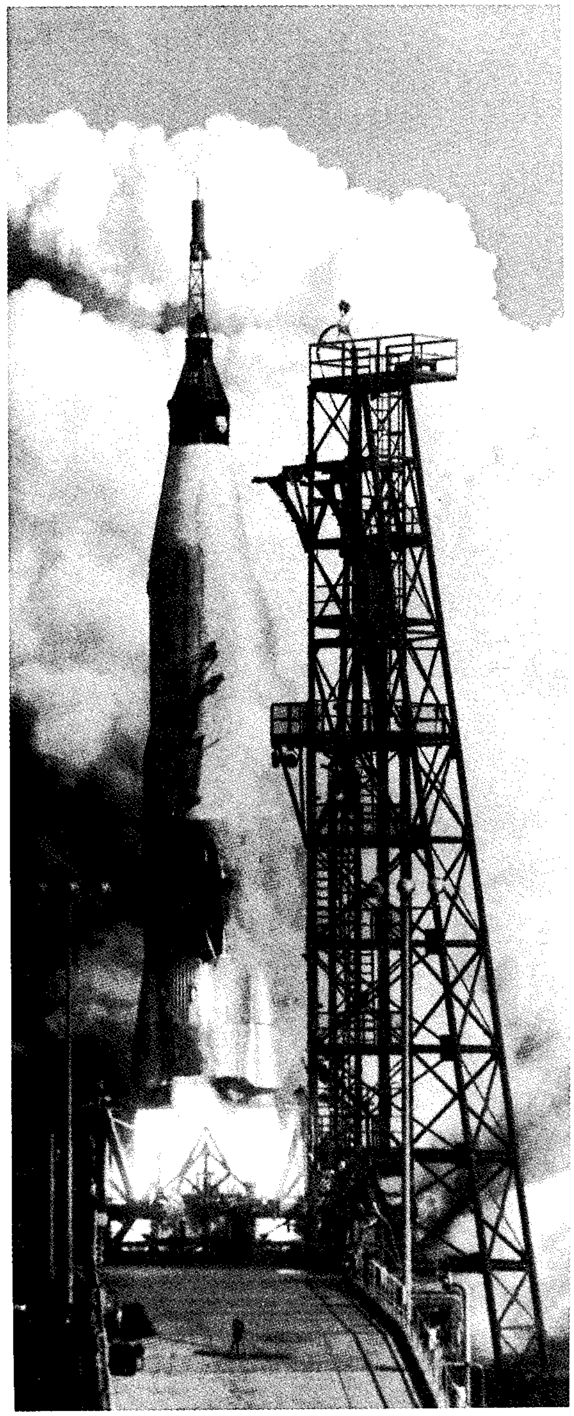
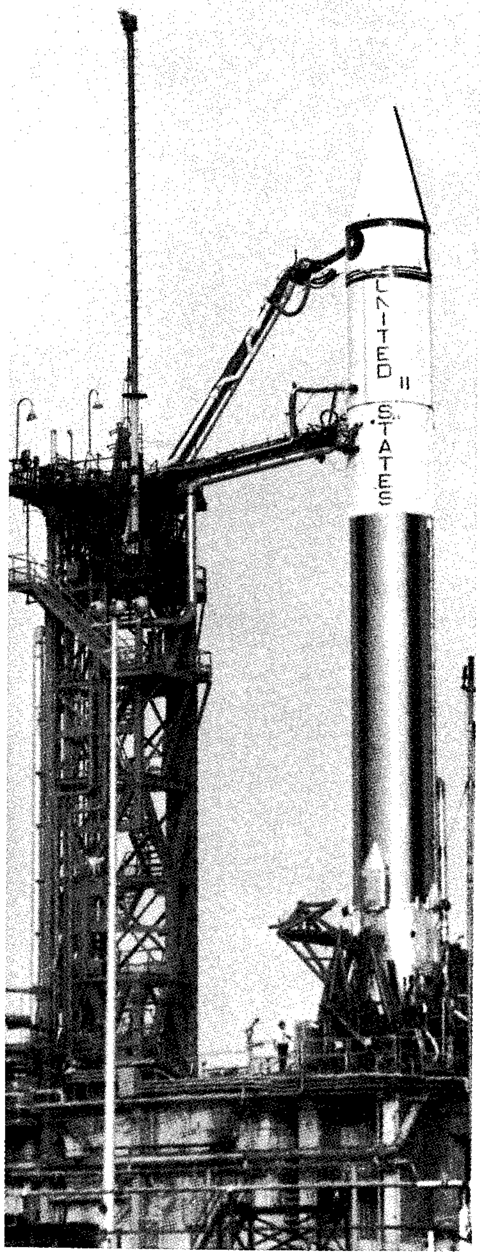
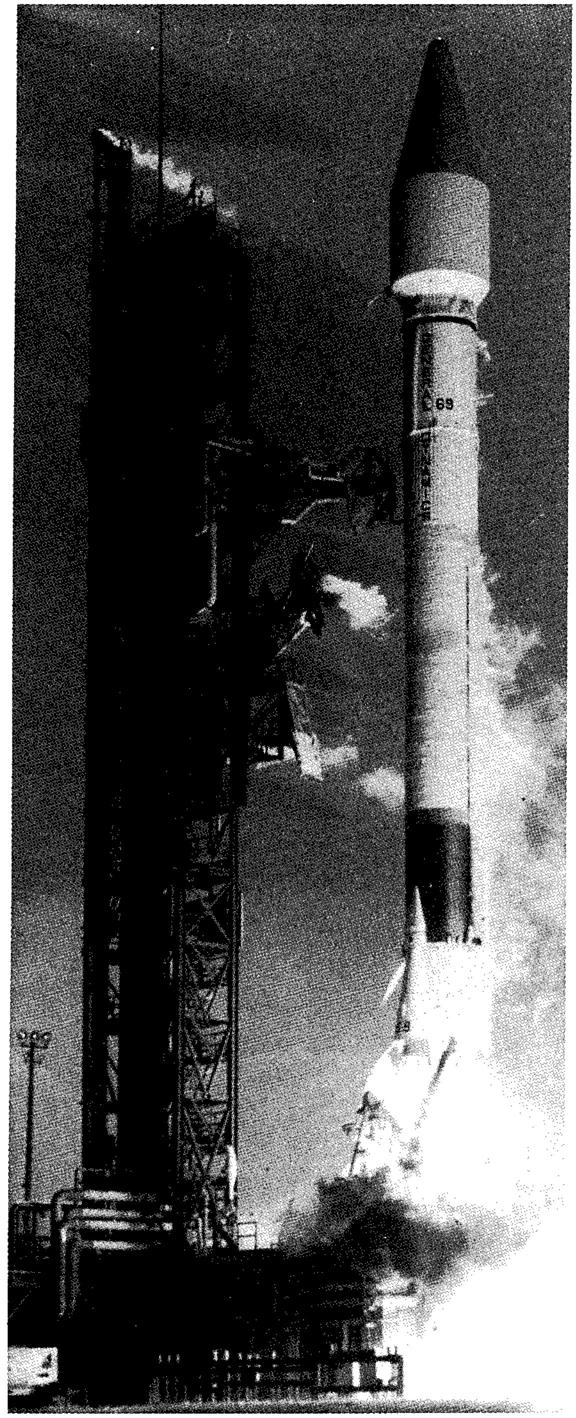


Official USAF photo

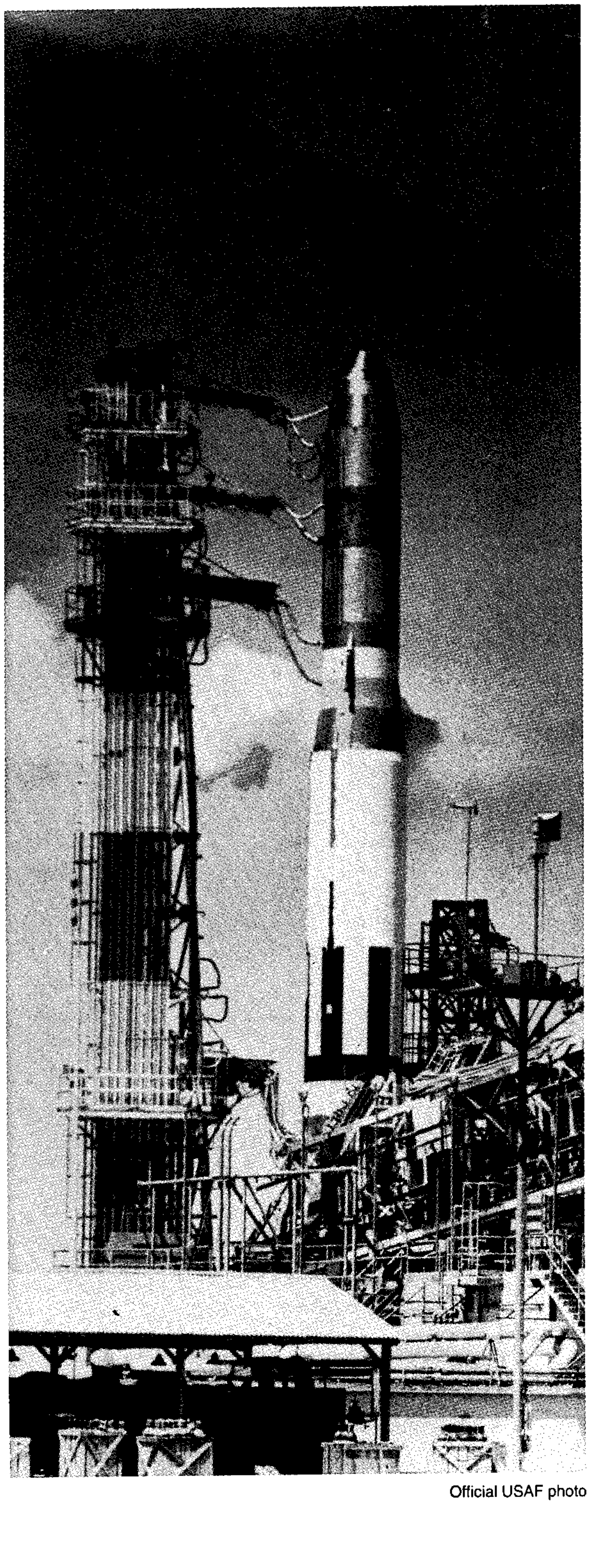
The Atlas goes to space. (Left photo) An Air Force Atlas with the MIDAS II satellite stands ready at Cape Canaveral (launch date 24 May 1960). (Right photo) A Project Mercury Atlas launches from Cape Canaveral on 25 April 1961.



Official NASA photo


Official NASA photo

(Left photo) A NASA Atlas Centaur vehicle prepares to launch a Surveyor from Cape Canaveral (launch date 14 July 1967). (Right photo) Another NASA Atlas Centaur launches the joint NASA/USAF Combined Release and Radiation Effects Satellite on 25 July 1990.



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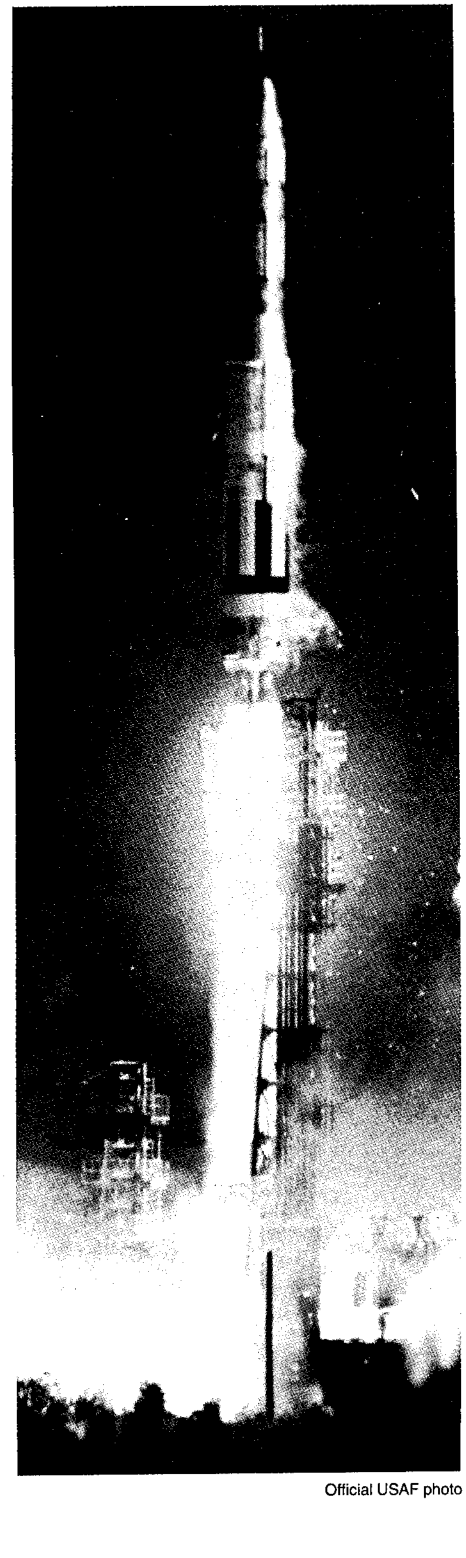
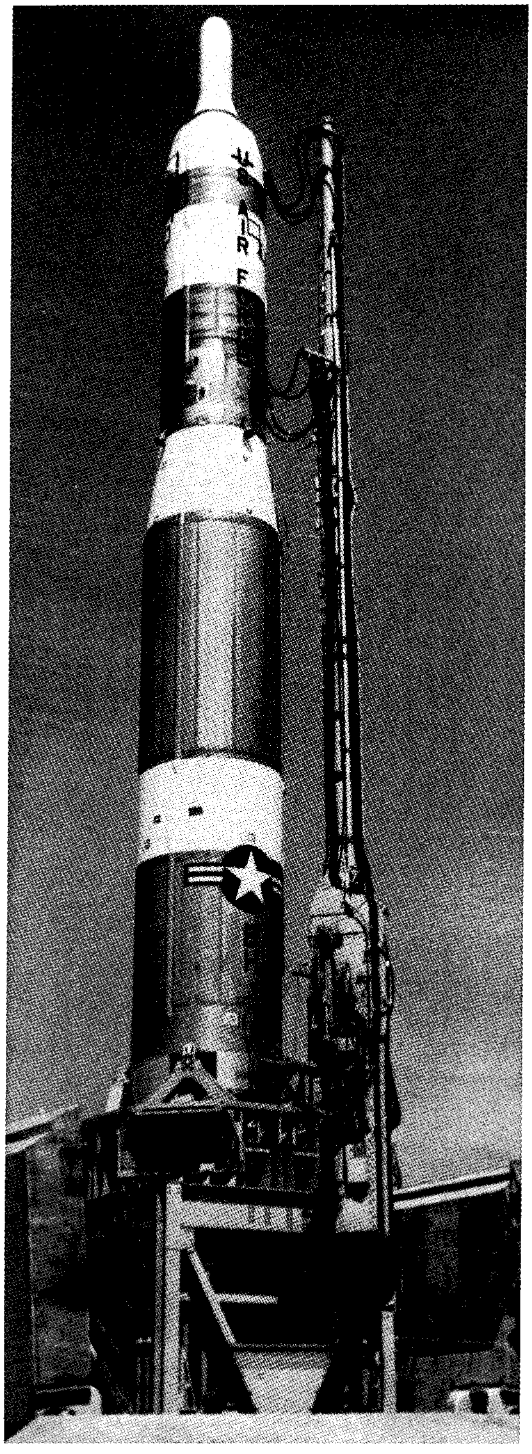


Official USAF photo

(Left photo) The first Titan ICBM is prepared for launch at Cape Canaveral. (Right photo) The maiden launch occurred on 6 February 1959.



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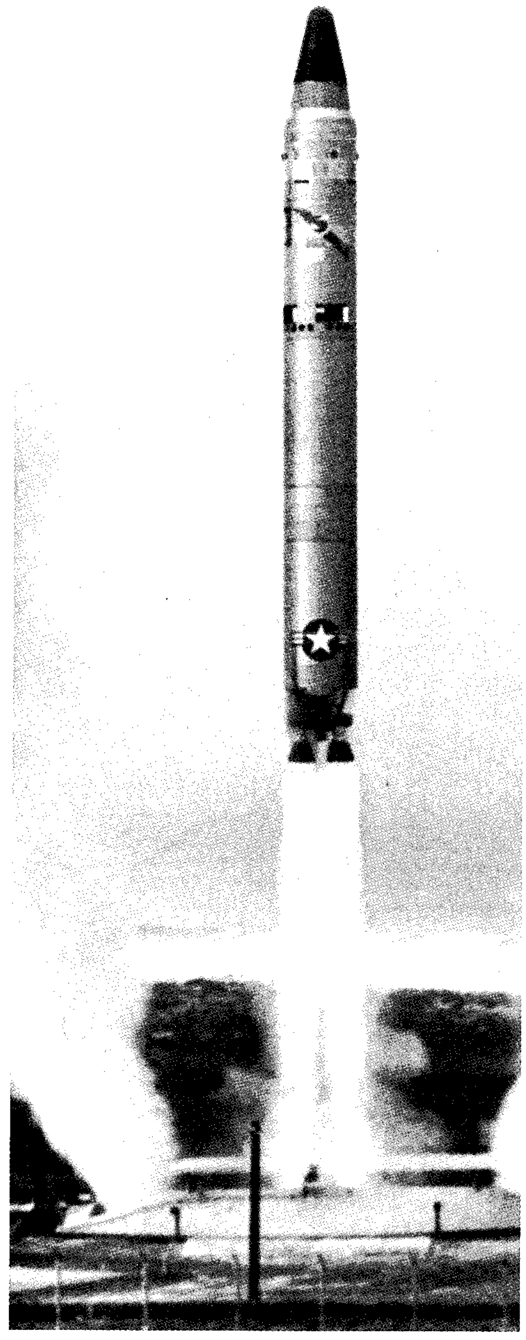
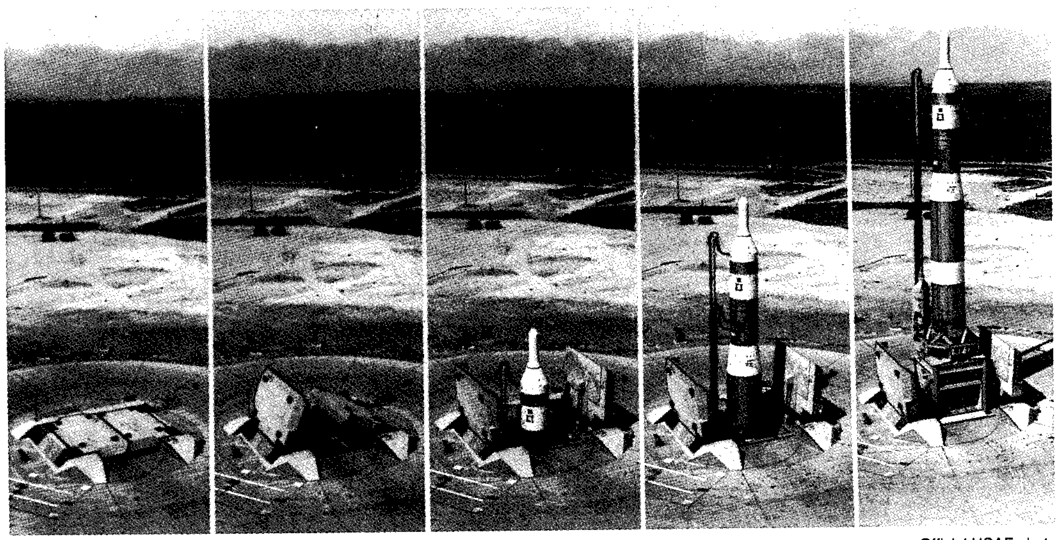


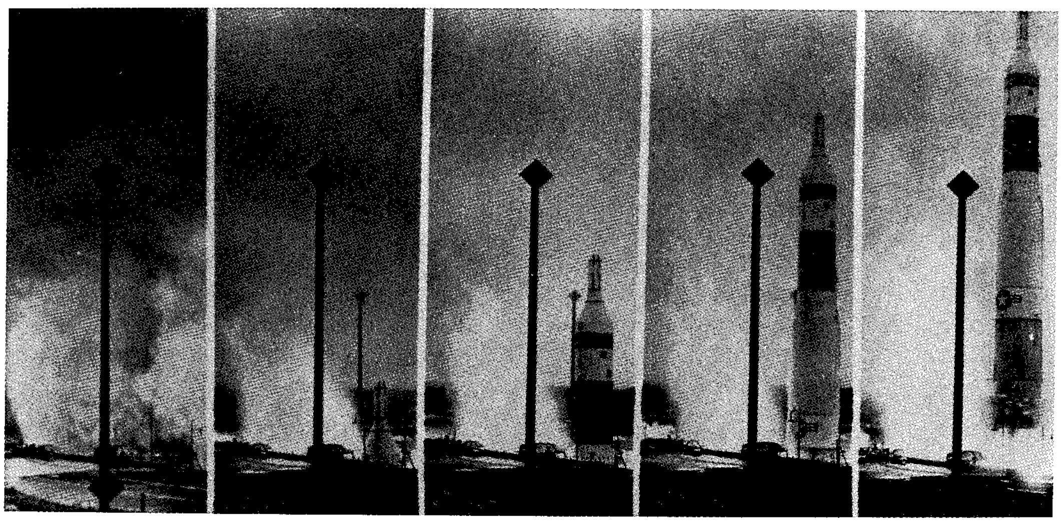
Official USAF photo

(Left photo) An early Titan ICBM above its underground silo in a test at Vandenberg AFB, circa 1961. (Right photo) A training launch of a Titan II ICBM, also at Vandenberg AFB, circa 1963.



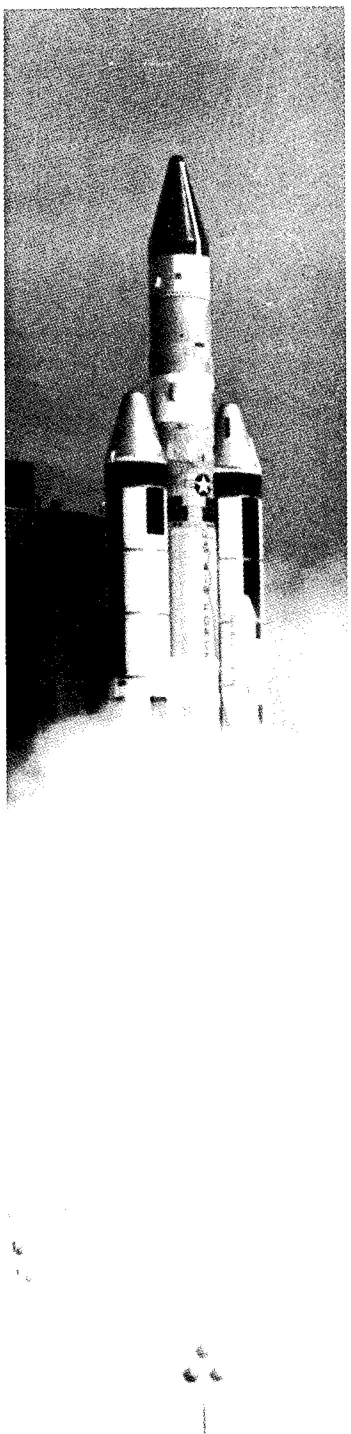
Official USAF photo

An early Titan ICBM rises from its underground silo during testing at Vandenberg AFB, circa 1961. Known as the Operational Systems Test Facility, this silo was a prototype for early Titan missile operations.



Official USAF photo

The first Titan II to be launched directly from inside a 146-foot-deep silo test facility at Vandenberg AFB on 3 May 1961.



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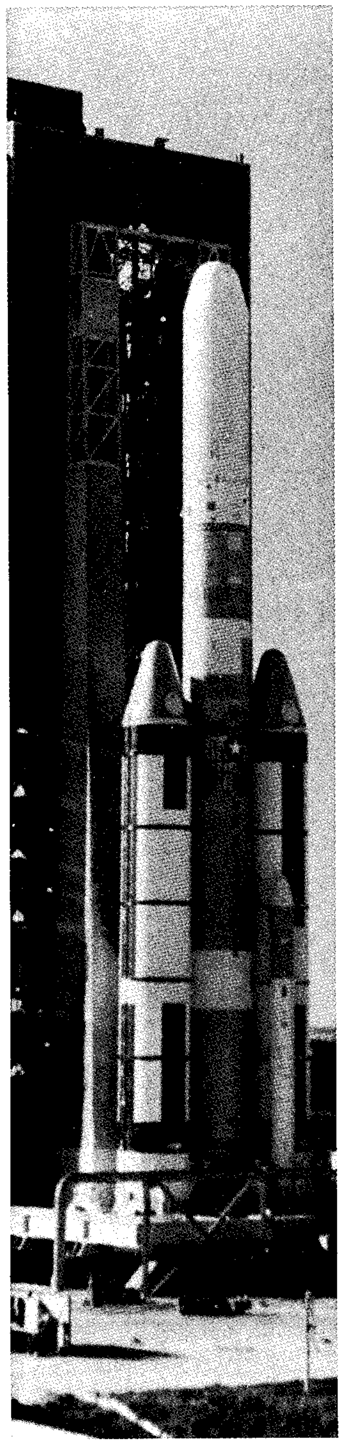

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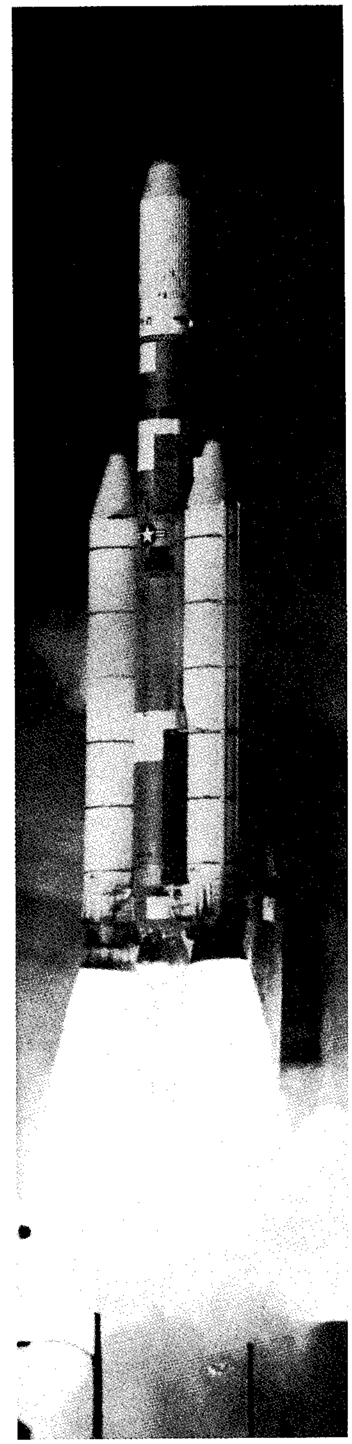
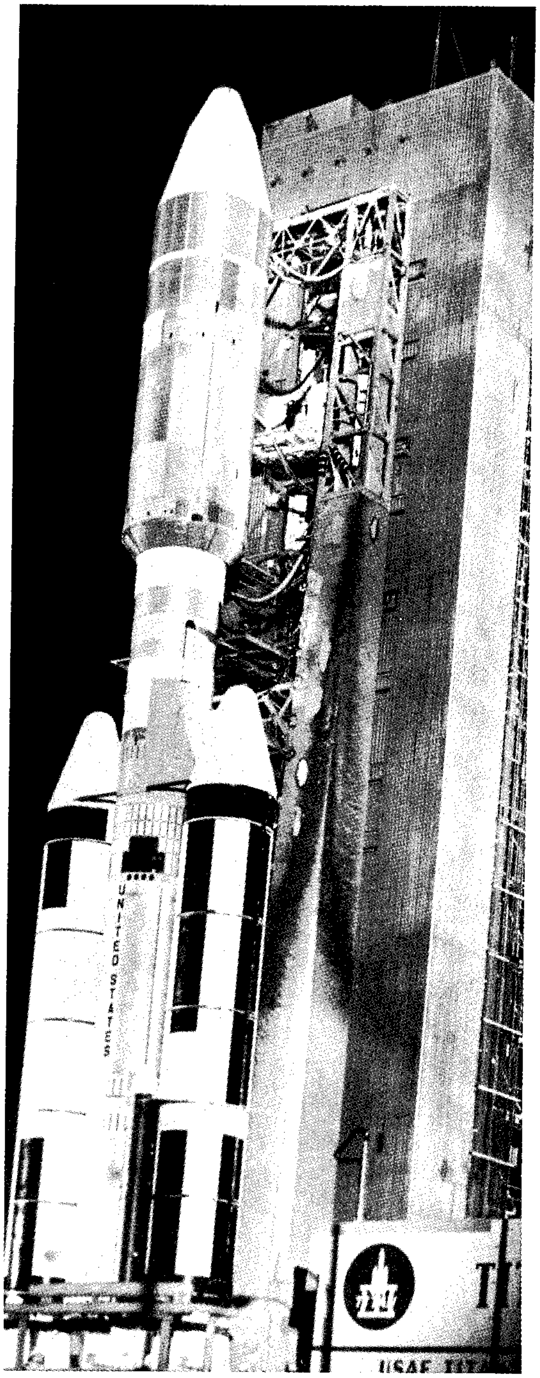
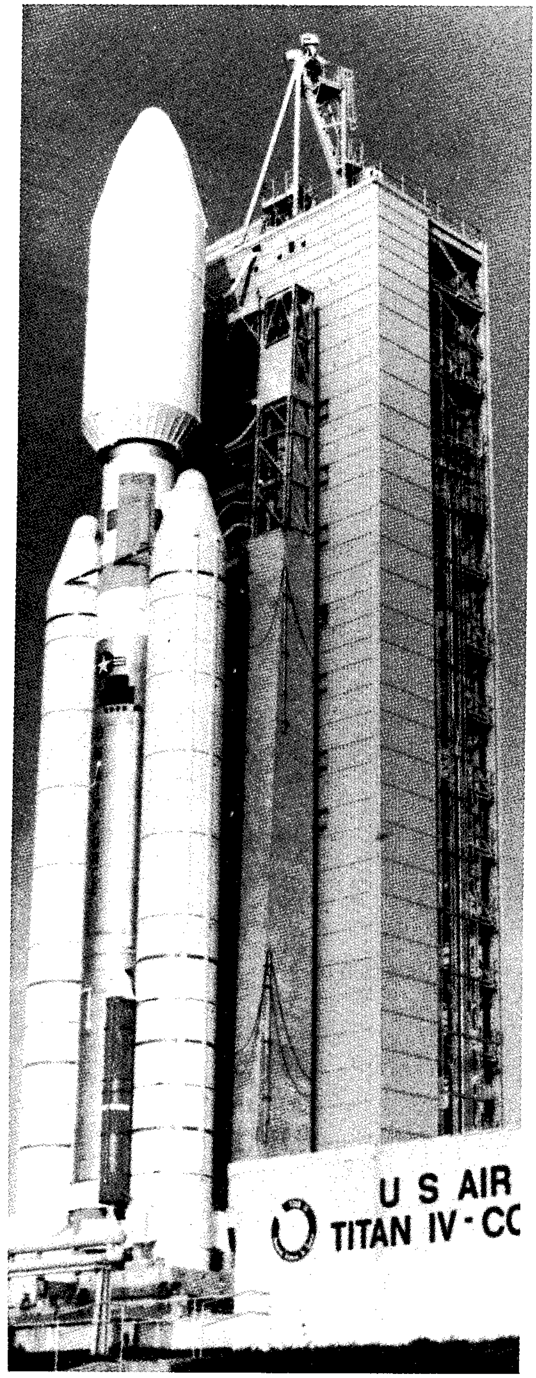


Official USAF photo

Three configurations of the Titan IIIC space launch vehicle. From left to right, the launch dates were: circa 1965, 9 February 1969, and 20 November 1979. Note the differences between the upper portions of each.

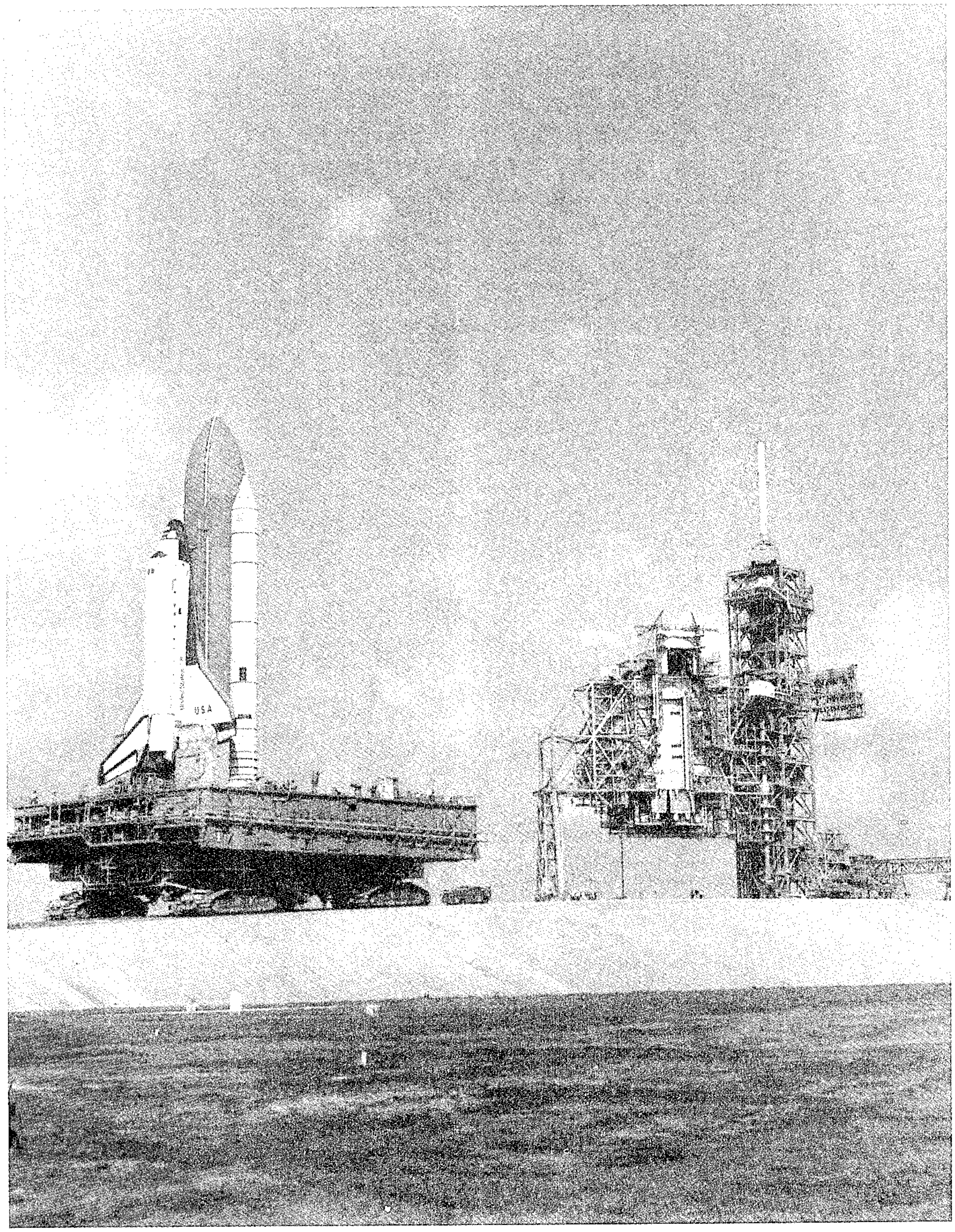


Official USAF photo




Official USAF photo

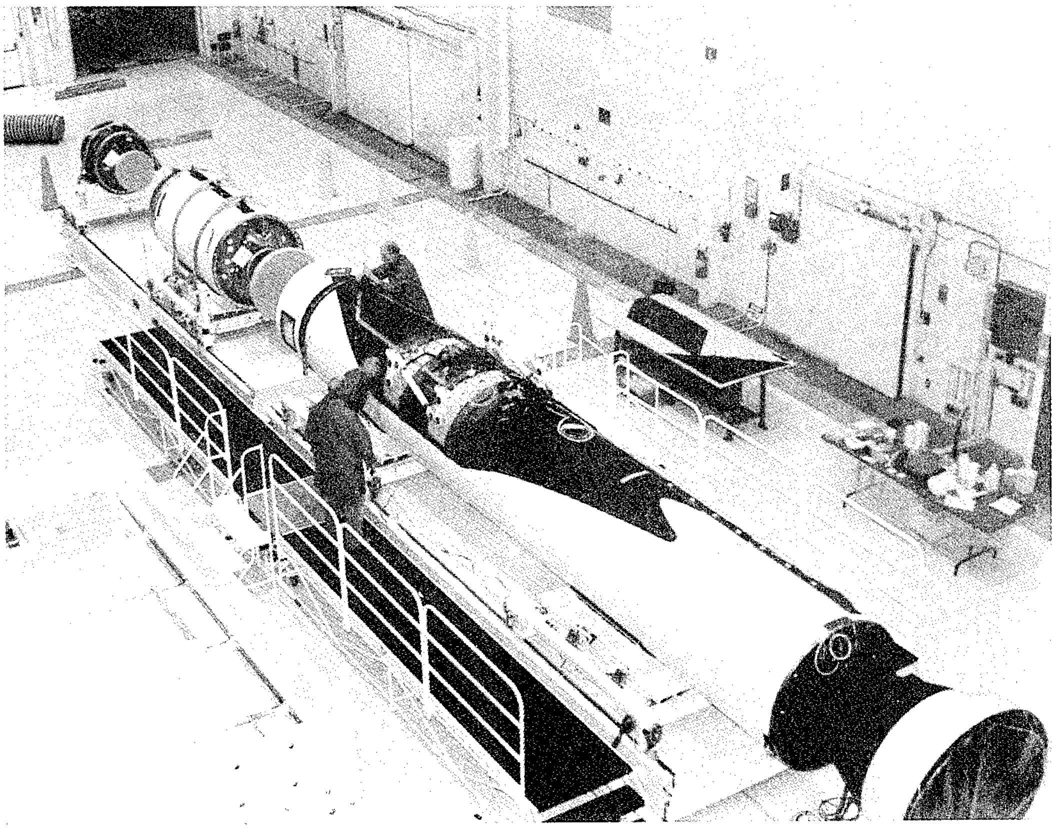
The Titan gets bigger! (Left photo) A Titan IIIC with Centaur upper stage sits at Cape Canaveral, circa 1970. (Right photo) An early Titan IV undergoes launch preparations at Cape Canaveral, circa 1989. Currently, the Titan IV is the largest US expendable launch vehicle with the ability to place 39,000 pounds into low-earth orbit.


Official NASA photo

The Space Shuttle, mission STS-3, rolls on its crawler-transporter toward pad 39A (16 February 1982). The immense and complicated support structure shown here does not include its various assembly and checkout buildings.

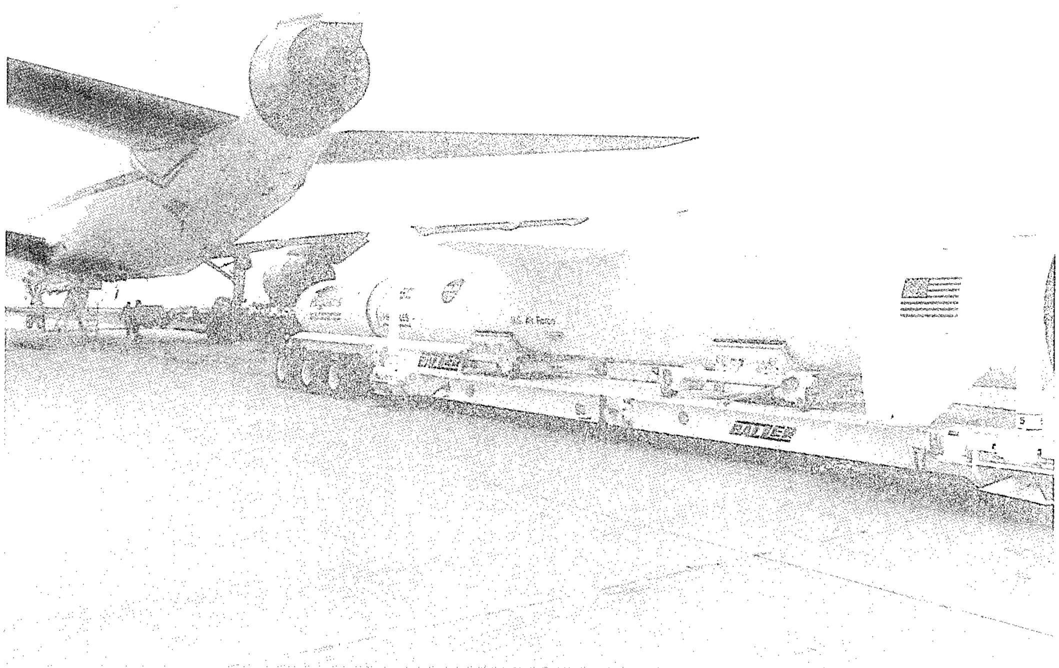
Official USAF photo

An Air Force Agena stage with multiple experiments aboard undergoes testing prior to delivery. Over 300 electrical connectors are checked simultaneously. Such complex support and test equipment are *common* and *accepted* in the space launch business.



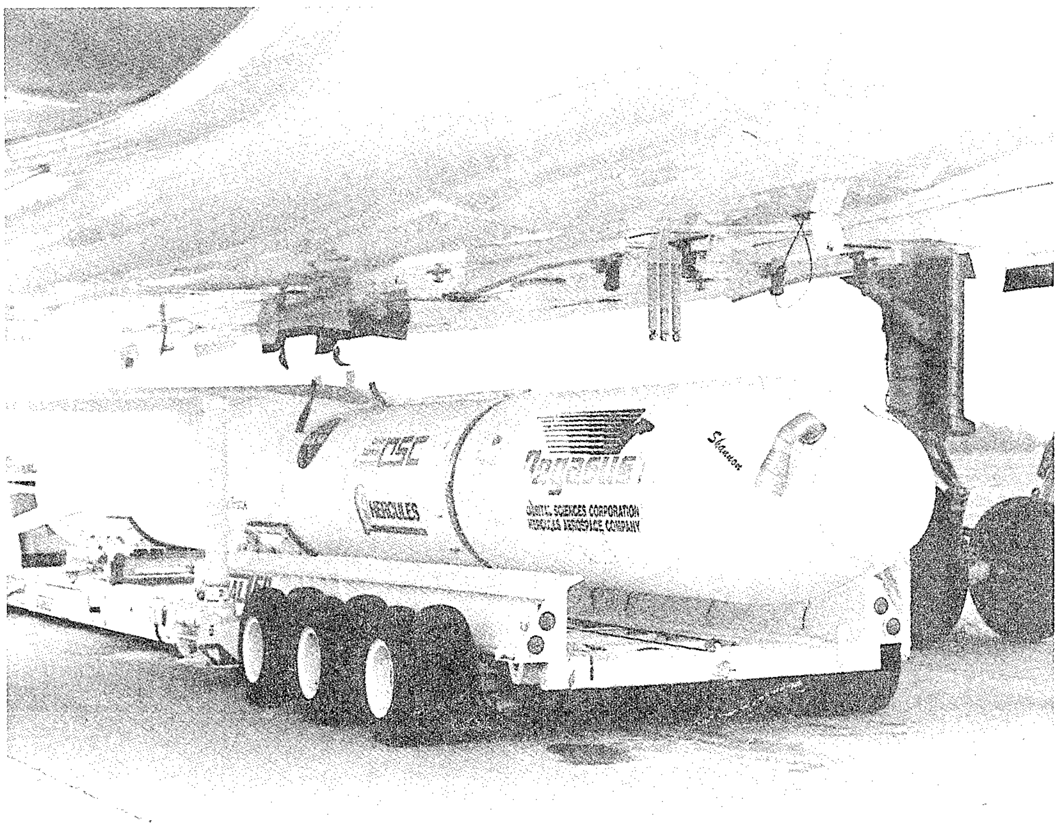
Official USAF photo

A Pegasus vehicle undergoes processing operations at Vandenberg AFB, circa late 1993. Pegasus is a winged, three-stage launch vehicle that is air launched from approximately 40,000 feet. The first Pegasus was launched on 5 April 1990 from a modified NASA B-52 aircraft.



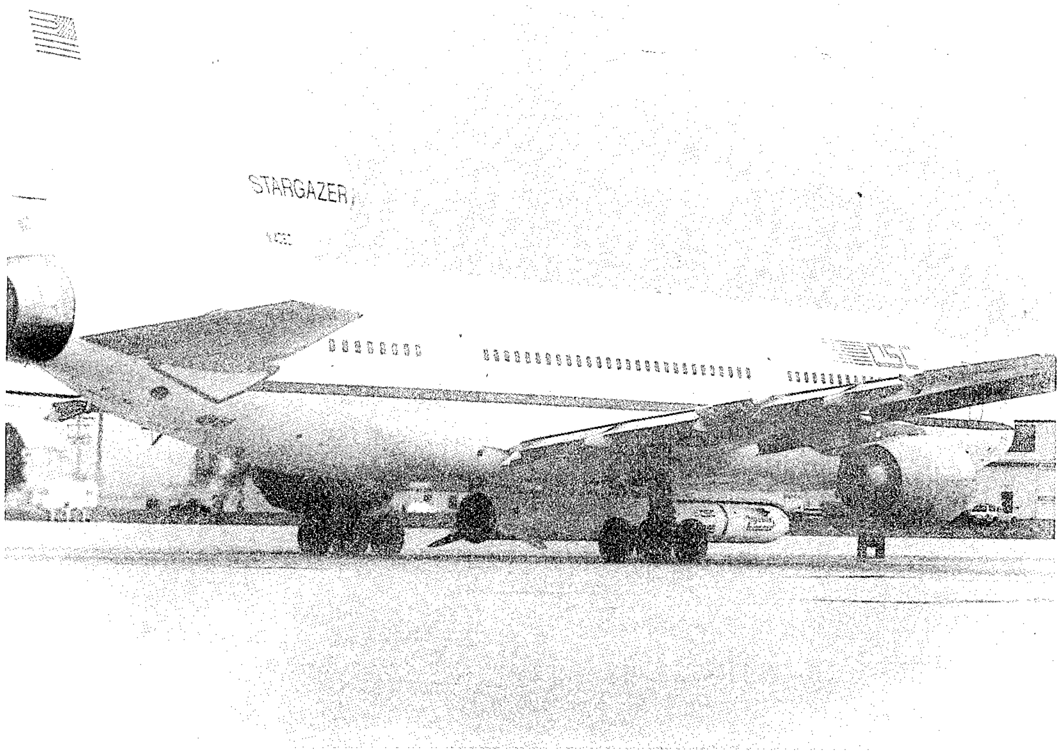
Official USAF photo

A fully assembled Pegasus inert test vehicle is transported to its new mother aircraft—Orbital Sciences Corporations's *Stargazer,* a modified L-1011. Test operations for this configuration were conducted at Vandenberg AFB in early 1994.




Official USAF photo

The inert test Pegasus *Shannon* is mated to the *Stargazer* mother aircraft at Vandenberg AFB in April 1994.

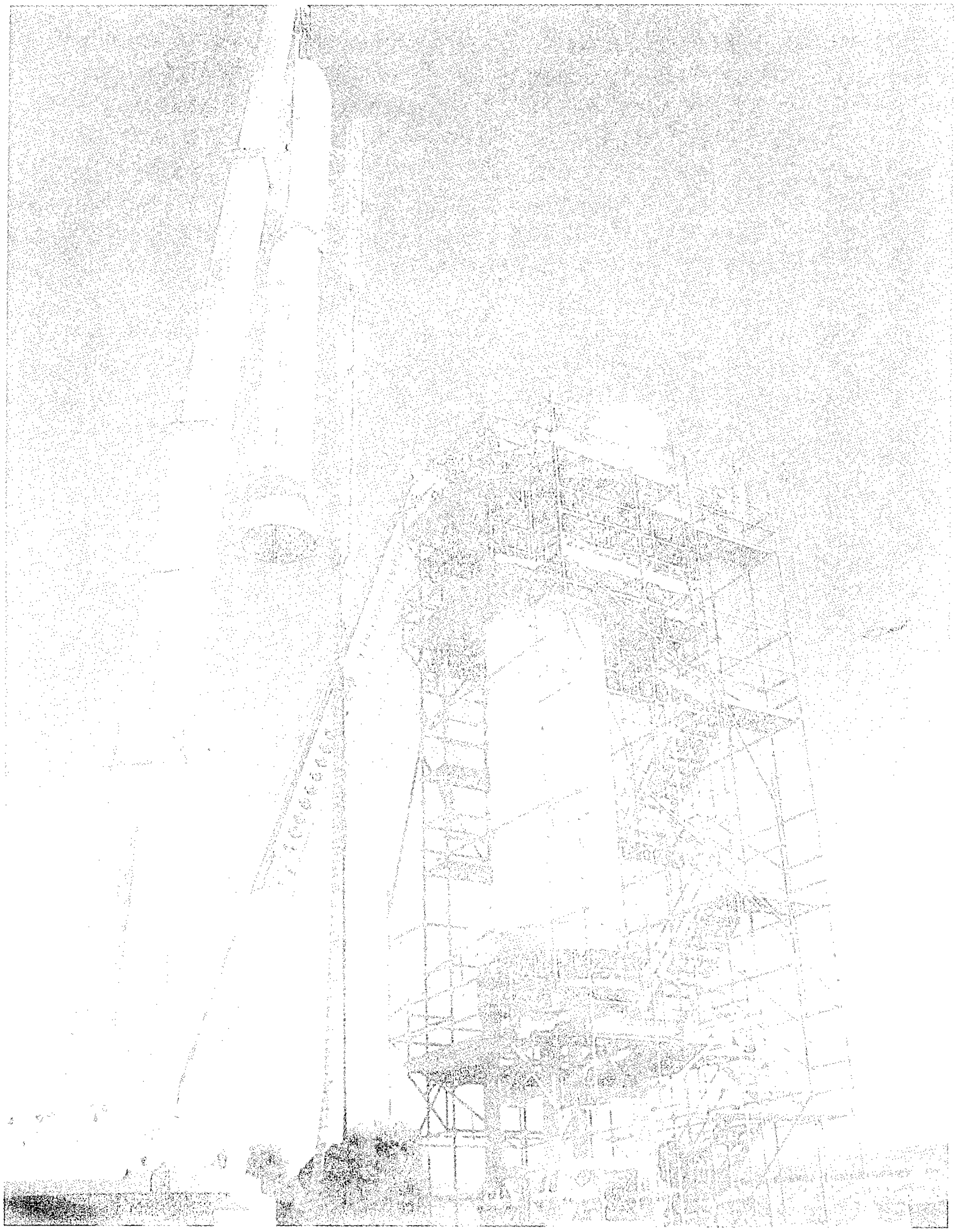



Official USAF photo

The *Stargazer* mother aircraft with mated Pegasus test vehicle taxies at Vandenberg AFB, bound for test flight off the coast of California (April 1994). The reduced infrastructure and flexible operations demonstrated by the Pegasus system offer food for thought for rapid-response spacelift systems.

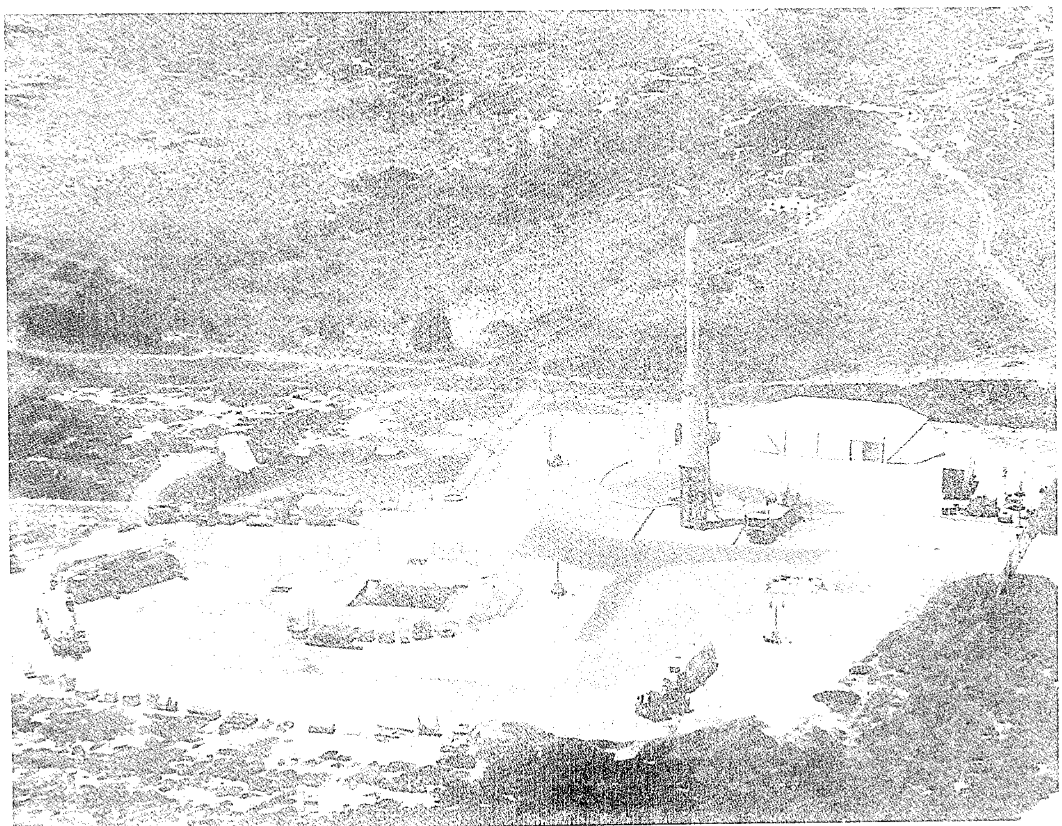
Official USAF photo

Atlas F launch site 576E at Vandenberg AFB, circa 1992. This site was cleared and slightly modified to serve as the first Taurus vehicle launch site. The Taurus consists of a modified Pegasus rocket mated to either a Peacekeeper ICBM or Castor 120 booster stage.



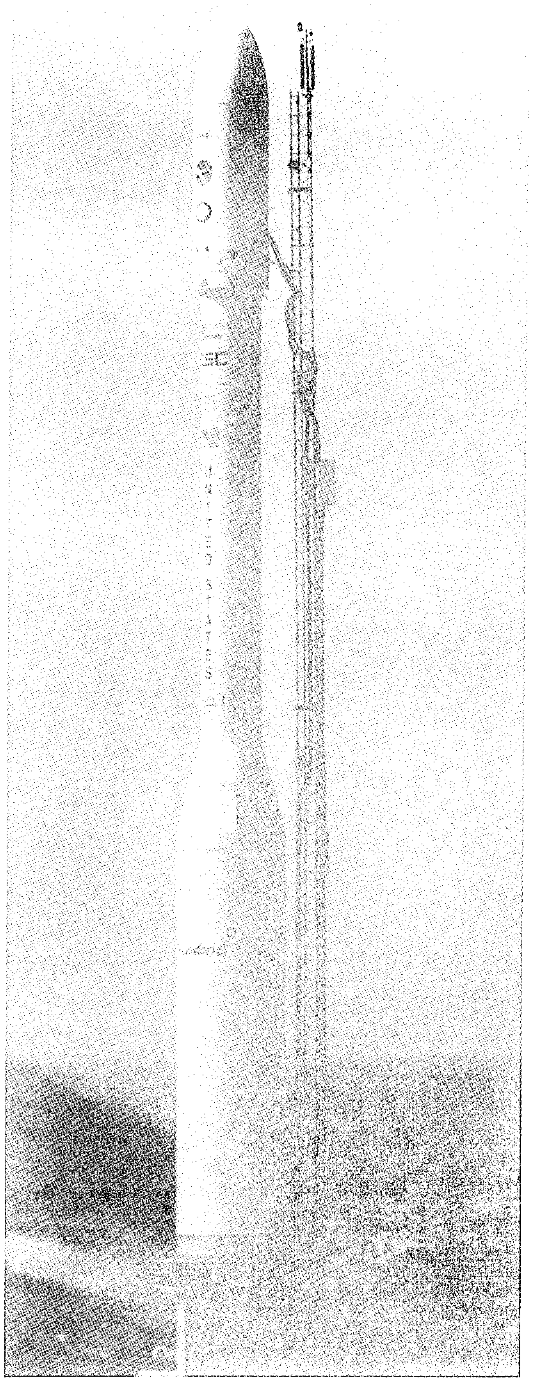
Official USAF photo

The upper three stages of the Taurus pathfinder inert test vehicle are lifted for mating to a modified Peacekeeper ICBM booster stage at site 576E, Vandenberg AFB, in late 1993. The scaffolding surrounding the vehicle is removed following assembly operations.



Official USAF photo

The fully assembled Taurus pathfinder at site 576E, Vandenberg AFB, late 1993. Note the simplified launch area—launch operations are conducted via a mobile control center van. All of the site infrastructure and launch operations equipment can be transported by truck to an austere location (concrete pad).



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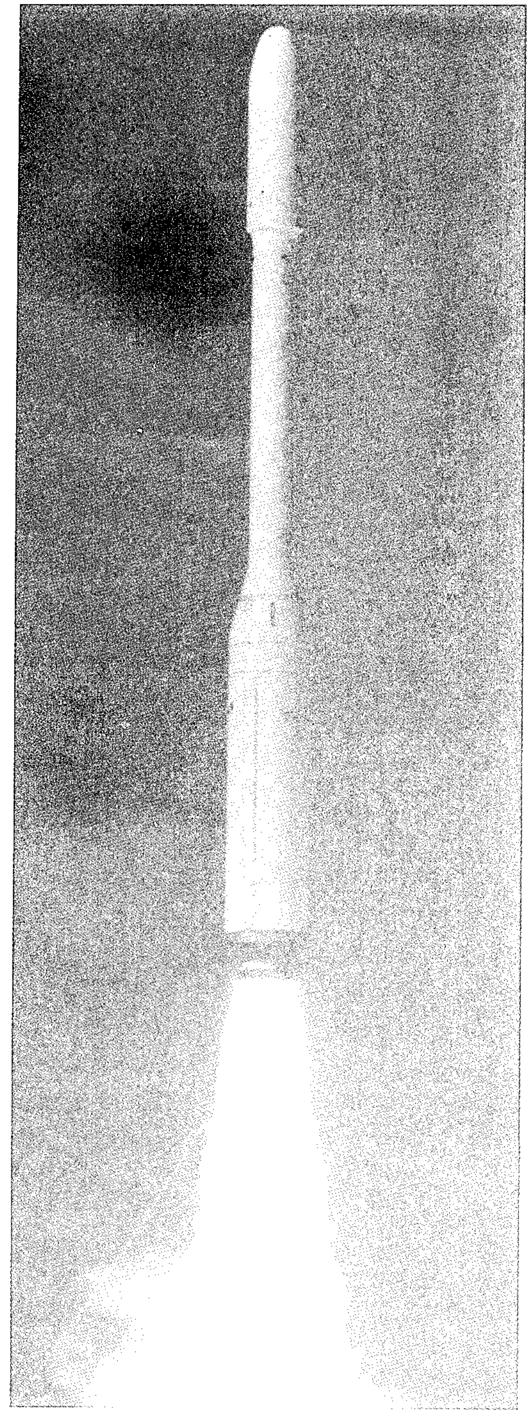


Official USAF photo

(Left photo) The first flight-ready Taurus—note the simplified pad structure. (Right photo) The first Taurus launch, Vandenberg AFB, 13 March 1994. The Taurus is designed to deliver over twice the payload of a Pegasus, although this capability has yet to be demonstrated.

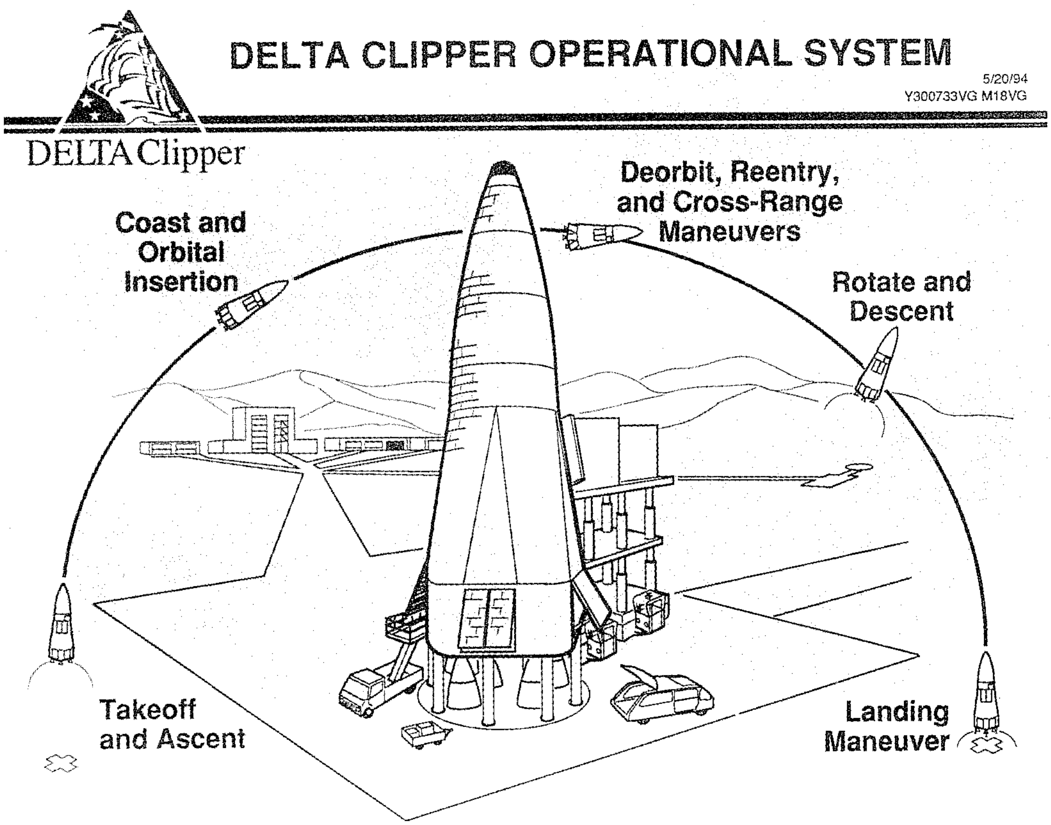



Photo courtesy of McDonnell Douglas Aerospace

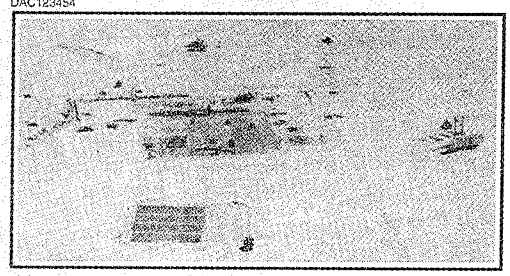
The proposed mission profile for the McDonnell Douglas Aerospace Delta Clipper single-stage-to-orbit spacelift system. The Delta Clipper system is still in development and testing. It has accomplished successful hover tests to demonstrate its lateral movement and vertical landing capabilities.

## TOTAL SYSTEM DEMONSTRATED AT THE CLIPPER SITE MINI SPACEPORT

5/13/94
Y300735VG 18UX

DELTA Clipper

DAC123454



Clipper Site

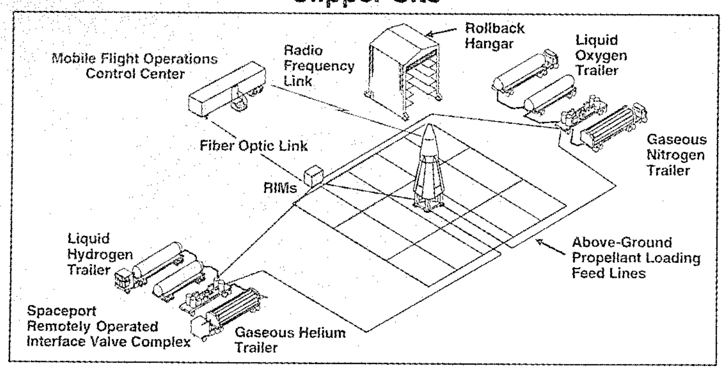



Photo courtesy of McDonnell Douglas Aerospace

The Delta Clipper Experimental (DC-X1) hover test site at NASA White Sands Test Facility, New Mexico. The line drawing illustrates the simplified launch infrastructure that includes an austere launch pad, mobile fueling and maintenance facilities, and a mobile flight operations control center.

## FLIGHT OPERATIONS CONTROL CENTER

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DELTA Clipper

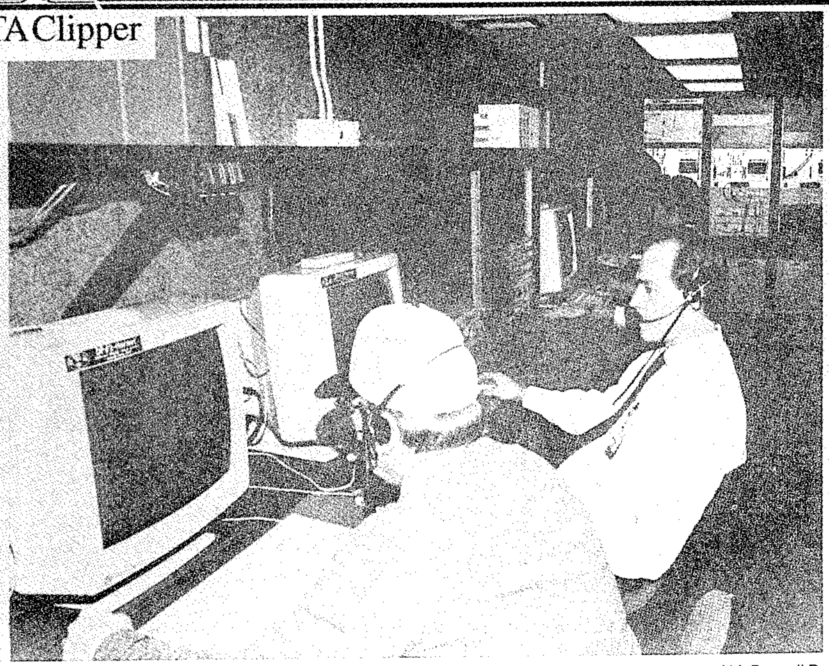

Photo courtesy of McDonnell Douglas Aerospace

The DC-X1 Flight Operations Control Center (FOCC). Ground and flight operations are controlled by a small crew in the FOCC located in a mobile trailer. Use of state-of-the-art computers and software greatly simplify test operations and reduce support personnel requirements.

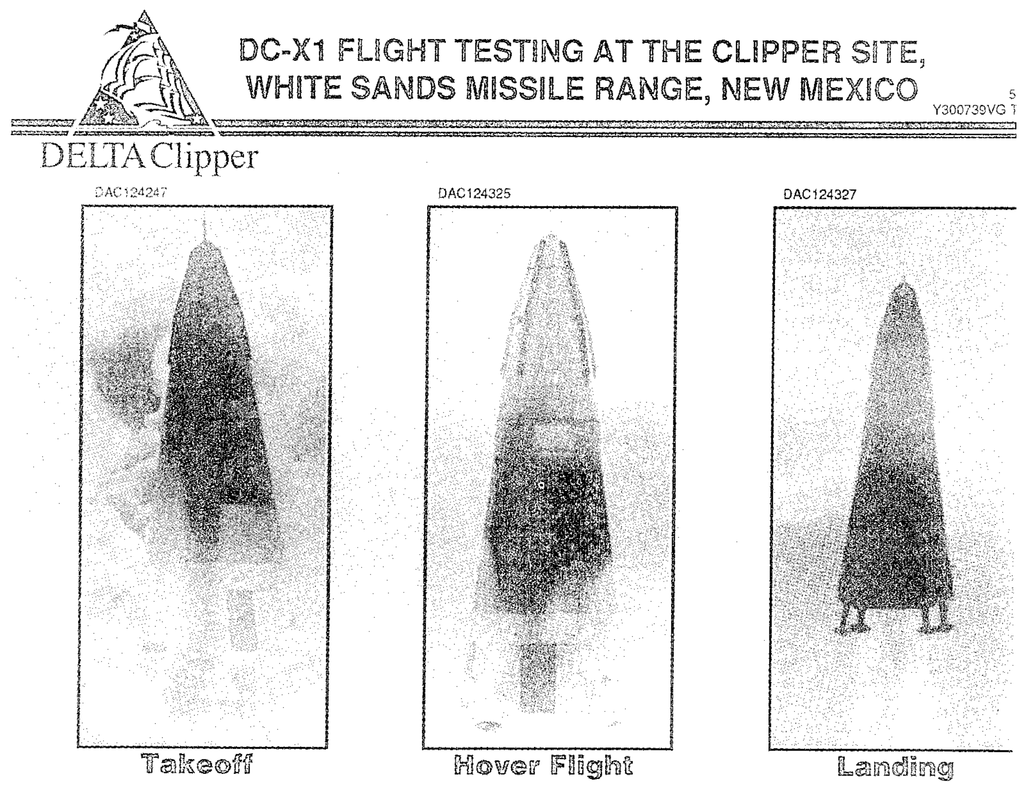


Photo courtesy of McDonnell Douglas Aerospace

A sequence of the first DC-X1 hover test at White Sands Missile Range on 18 August 1993. The DC-X1 is a one-third scale of the proposed operational Delta Clipper system. An operational full-scale Delta Clipper may be a candidate system to provide rapid-response military spacelift.

## Chapter 4

# The Possibilities

*Why can't they buy just one airplane and take turns flying it?*

—Calvin Coolidge

President Coolidge's approach to airplanes seems to live on in the world of space support—military satellites must be shared among many users. As discussed in the previous chapters, this attitude illustrates that the US is not properly anticipating the future character of war in space, despite clear indications of its importance as demonstrated in recent conflicts. Current spacelift assets cannot provide the support necessary to reconstitute critical force-enhancing satellites in a combat environment. One of the pitfalls of previous spacelift studies has been that participants have all had "back-pocket" agendas to sponsor specific systems. To avoid this parochialism, this chapter does not propose specific systems to solve our combat deficiencies in space. Rather, it provides a vision toward the solution.

## Paradigm Shift

As discussed in the last chapter, our current military spacelift vehicles have evolved for over 30 years from their ICBM roots. This evolutionary approach has developed well beyond the point of diminishing return, requiring great expense for incremental performance increase. This continued pursuit of "one more modification" is a cancer upon our nation's space force, with a tremendous appetite for resources which, when fed, only makes the system weaker. It is time to break this vicious cycle.

A more radical approach to spacelift is to pursue exotic technologies that will offer revolutionary performance increases. Antimatter, antigravity, electromagnetic, and other such propulsion technologies may be available in the distant future. However, existing spacelift deficiencies require immediate attention if we are to provide combat space support to war fighters. Neither the evolutionary nor the revolutionary approach can resolve spacelift deficiencies—a new approach is required. However, before presenting this new approach, we must examine a key misconception within the current view of the US military in space.

## The Misconception: Technology and Capability

In his book *Strategy and Ethnocentrism,* Ken Booth points out that "In strategy, pride is literally a deadly sin. Belief in national superiority has contributed to some spectacular military failures."[1] Based on our current approach to spacelift, this statement could be a harbinger of disaster in a space war. We have an illusion of superiority, thinking that superior technology equates to superior combat capability. Indeed, an August 1993 white paper from US Space Command stated: "It's important that the US maintain its superior space capabilities."[2] Unfortunately, the paper didn't address the circumstances under which the asserted superiority exists. The future environment of space operations may be that of a shooting war. A better approach, then, is to state: It's important that the US *develop* superior *war-fighting* space capabilities.

## The De-Evolution of Spacelift—A Paradigm Shift

The primary problem with our current spacelift system is that it ignores a fundamental truth—no one can build a perfect system. Murphy's Law will always apply, and during war it will be augmented by Clausewitzian fog and friction. Our current spacelift operations seem to embody the belief that if enough money, studies, people, and quality assurance are thrown at a system, it will become perfect. However, this approach overlooks another fundamental truth—a system doesn't need to be perfect if it is designed to be robust and fault-tolerant. Applying these two truths to our spacelift shortfalls points to a solution that is away from our current systems and toward the technologically "inferior" systems of the former Soviet Union (FSU):

> If the Soviets use technology that is primitive by our standards but meet their mission requirements while we fail to satisfy ours, then their technology is better by any sensible standard of military utility. . . . In fact, if the cruder Soviet system allows greater latitude for error and thereby yields greater reliability, then for all practical purposes it is a better system.[3]

This backing away from current razor-thin, high-technology design margins to the robust "duct tape it before launch" approach of the FSU[4] represents a significant paradigm shift—a "de-evolution"[5] of technology that is required to increase *operational utility.* This approach can lead to a rapid-response spacelift system that emphasizes standardized procedures, short sortie-generation times, robust design margins, and simplified launch site operations.

This is not to say that advances in technology are bad. However, the application of these advances must be balanced against operational utility and design margin. Just because a system can be designed within 1 percent of structural failure doesn't mean it has to operate that way. Engineers may need to throw away their complex computational fluid dynamics design software and learn to use a slide rule again—the point being that common sense and intuition should be emphasized over blind faith in computer simulations. Technicians and maintenance personnel should also have a say in the design process to help reduce the complexity of operations.

### De-Evolution: An Example

To better understand the concept of de-evolution, consider the common automobile. Almost all new cars use fuel injection and electronic ignition versus the mechanical carburetor and distributor ignition systems of yesteryear. The new models offer better fuel economy and more optimized performance—but only when the modules are working. When they fail, they tend to do so in a catastrophic manner, leaving the car unable to function. Repair work is expensive and requires specialized training and support equipment; it is beyond the capability of the average operator.

On the other hand, the older cars offer greater operational utility. Their robust systems tend to degrade before total failure, allowing the operator ample time to bring the car to a service station. In many cases, the repairs can be performed by an operator with basic system knowledge—and less support equipment is required. Because of their simplicity and standardization, replacement parts are usually less expensive also.

Obviously, the newer model cars will deliver superior performance when they are operating. However, when Murphy's Law crops up, the older (i.e., de-evolved) cars are the best bet to provide basic transportation that is fault tolerant and easy to maintain—superior operational utility.

## System versus Vehicle Approach

The primary goal of the de-evolution approach to RASFOR is to emphasize operational utility in the design of the *system.* While specifications may accomplish this, they often miss the "big picture" by getting lost in the specific details of the vehicle. The development of the F-111 aircraft is a good example. Although it is now a very capable weapon system, strict adherence to arbitrary design specifications needlessly drove up development costs and delayed its schedule. If the overall mission and concept of the F-111 system had been more clearly stated and followed, many of these specifications would have been reconsidered to the benefit of the program.[6]

Similarly, in developing RASFOR, the entire system must be considered. Even if a vehicle can be developed to launch in hours, it is of little use if it takes months to assemble, checkout, or emplace at its launch facility. Taking it one step further, the operational ends of RASFOR are worthless if the satellite it carries takes a long time to check out on orbit. The use of lightsats, with fewer subsystems and lesser mass, could dramatically reduce the time required for on-orbit operations.

### Cost

One of the greatest challenges facing the military today is the reduced budgets under which it must operate. This is reflected in the current DOD space investment strategy, which has a fundamental goal "to make future DoD space

systems more cost effective while retaining U.S. technological superiority." It emphasizes "reduced procurement and life-cycle costs consistent with operational requirements,"[7] but follows the paradigm that the technological superiority will satisfy operational requirements. This misguided approach has led DOD to continue the evolutionary process of spacelift; in essence, a decision to throw good money after bad. This is not a temporary measure; the decision will extend the life of the current launch vehicle fleet to the year 2030—banking on many subsystems which embody 60-year-old technology.[8] Also, by 2030, the government will have spent $393 billion on spacelift under this status quo approach.[9]

The problem with this proposed strategy is that it ignores other elements of cost. In choosing the status quo approach to spacelift, DOD is sentencing spacelift to remain nonresponsive and manpower-intensive into the twenty-first century. An old Chinese proverb says: "Where there is no gain, the loss is obvious."[10] If US military spacelift remains the same while others proliferate, how can we do anything but lose? Economists refer to "opportunity cost" as the cost of selecting a given approach and the resulting benefits foregone by not using the best alternative.[11] Unfortunately, the opportunity costs of this decision may be the loss of US lives during conflicts with enemies that have war-fighting capabilities in space. To avoid this, current and future studies concerning spacelift costs, especially those that make cost "the primary measure of merit,"[12] must address the opportunity costs faced by using peacetime systems in a combat environment.

### Risk Reduction versus Risk Distribution

Under the evolutionary approach to space operations, risk reduction was accomplished by tedious quality assurance checks and extensive system redundancies. One of the greatest benefits of a RASFOR approach is that operational risk is distributed—the dilemma of having all the eggs in one basket is avoided. This concept of risk distribution can prevent the recurrence of previous billion-dollar losses such as the Titan IV SLV incident of August 1993.[13] Also, this concept will drastically reduce the need for quality checks and redundancies, thereby reducing procurement and operating costs.

### Simplicity

In pursuing a RASFOR system, simplicity must be emphasized to avoid the pitfalls of complicated evolutionary systems. Simplicity of equipment and operations can significantly increase the utility of spacelift. Specific methods to reduce system complexity include the standardization of equipment and procedures. Boosters and satellites could be developed with common modular elements and standard interfaces. These measures would reduce procurement costs by introducing larger production buys with fewer configuration changes.[14] Repeatable procedures can reduce training requirements and reduce the chance for error.

A major contributor to the complexity of current systems is infrastructure, which includes many elements: transportation, handling, and test equipment; storage, assembly, and launch facilities; and command, control, and range operations centers. These required elements not only complicate spacelift system operations, but they also carry their own logistics and maintenance problems. During RASFOR system design, a conscientious effort should be made to make maximum use of existing military infrastructure, thus reducing the need for specialized equipment. Simpler systems with less infrastructure can also reduce the manpower required for operations, thus saving costs and reducing the chance that human error will cause the system to fail.

**The Proper Use of Technology**

It is not the purpose of this chapter to bash technology. Nor is it to make light of the tremendous accomplishments of our national space programs. However, it is intended to warn against the US resting on its space laurels. We cannot continue to contend that, during war, our advanced technological capabilities and industrial base can make up for short-sighted strategic plans made during peace. During the development of RASFOR, technology must be seen in its proper light—as a *possible means* to a solution, *not* the solution itself. The technology that offers the greatest simplicity and operational capability must be selected, even if it is not the most "advanced" of choices.

One of the most promising advances of the next decade fits well to the RASFOR approach—microtechnology. NASA's Jet Propulsion Laboratory has already been able to reduce the size of a certain transducer from the size of a soda can to a mere cubic millimeter. Not only does microtechnology save weight, space, and power, but in some cases it may provide instruments that are actually more sensitive than their larger predecessors.[15]

**Military First**

Contrary to the recommendations of numerous spacelift studies that have been conducted since the *Challenger* disaster, combat-capable space systems should be pursued without the influence of civil and commercial interests. While civil and commercial space programs entail large expenditures, they represented only 0.24 percent of the 1992 gross domestic product[16]—hardly a threat to US economic viability. In contrast, existing and proliferating foreign military space capabilities present a potential threat to US national security. This is not to say that civil and commercial space industries cannot benefit from the more capable military systems produced through de-evolution. However, their benefit should be derived only after the military system has been established.[17] To do otherwise would open the door to a long and complex consensus-building process[18] that would further delay the deployment of a critical combat capability.[19]

**Options to Consider**

In the development of RASFOR, there are several "optional" areas to consider with potentially large payoffs in terms of operational utility. In actual launch

operations, the concept of making the lift vehicle have an abort capability may have merit. The current approach ("lighting the candle") entails 100 percent commitment when the booster is ignited—the system either flies or it dies. An abort-capable vehicle could have built-in subsystems to rescue the payload, and perhaps even the entire vehicle, if sudden loss of the main propulsion system occurs. The decision to pursue this capability should be based on trade-off studies which consider complexity, reliability, operational requirements, payload and vehicle availability, and cost.

The implementation of RASFOR could introduce a new option for heavy lift—on-orbit assembly. While this option may require the development of robotic orbital transfer and assembly vehicles, it also offers many advantages over the current one-shot method. As discussed in previous paragraphs, the risk of the full system would be distributed over several launches. Also, if a subsystem fails during on-orbit checkout, only that portion would need to be replaced via RASFOR. If the RASFOR has a parallel launch capability, or if its launch turnaround time is sufficiently short, then the entire heavy system can be on-line in the same or less time than is currently possible.

For the case of heavy systems that may not be amenable to being broken down into smaller subsystems (such as a space station structural element), RASFOR may be used in conjunction with conventional heavy lift under what may be termed the "90/10 split" method. In this approach, the majority (possibly 90 percent) of the payload is "dumb" weight—structure, fuel, supplies—while the remainder (possibly 10 percent) of the payload is the "smart" weight—electronics, sensors, solar cells. The 90/10 split puts the "dumb" payload on conventional heavy lift and the "smart" payload on rapid-response spacelift, thus providing the capability to rapidly replace any "smart" subsystems that fail to checkout on orbit.

## Increased War-Fighting Capability

The primary objective for developing and employing a RASFOR system is straightforward—*provide responsive and flexible space support to the war fighter.* This support is a key enabler for space-based systems that serve as force multipliers to increase the nation's war-fighting capability. A RASFOR system can provide the increased satellite sortie generation rate that may be required to replace failed satellites or to augment existing constellations.

The use of lightsats can provide more capable and less vulnerable satellite systems. Having a distributed constellation of many lightsats versus a few conventional satellites can be compared to a networked system of personal computers versus a larger mainframe. In both cases, the loss of an element in the distributed system will have a much less dramatic effect on overall system performance than a loss in the mainframe environment. Also, problems within the system are easier to diagnose and repair. From an adversary's viewpoint, the distributed system presents a challenging situation—more targets of less value

each, making the overall system less vulnerable to attack. A distributed lightsat system coupled with a RASFOR system would present the enemy with a modern-day Hydra: for every satellite "head" cut off from the constellation, the RASFOR system could be used to "grow" its replacement.

Smaller satellites designed with shorter operational lives could also provide more capable support to the war fighter. The director of the NASA Center for Space Microelectronics Technology addresses the advantages of smaller systems:

> Instead of launching every decade, we launch every year or two years, which maximizes the possibility for insertion of new technology . . . and you minimize your risk by distributing the launch over five launches instead of one.[20]

Figure 5 illustrates the capability advantage possible using shorter-life lightsats. As applied technology continues to advance in the future, satellite capability will parallel these advances. Both short-life (e.g., two-year life) and long-life (e.g., 10-year life) satellites incorporate available technology advances into their next generations of design. However, the short-life systems are able to go through five generations of improvement for every one generation of the long-life system. The final result is that the short-life system will have a capability advantage over the long-life system for eight years of its life.

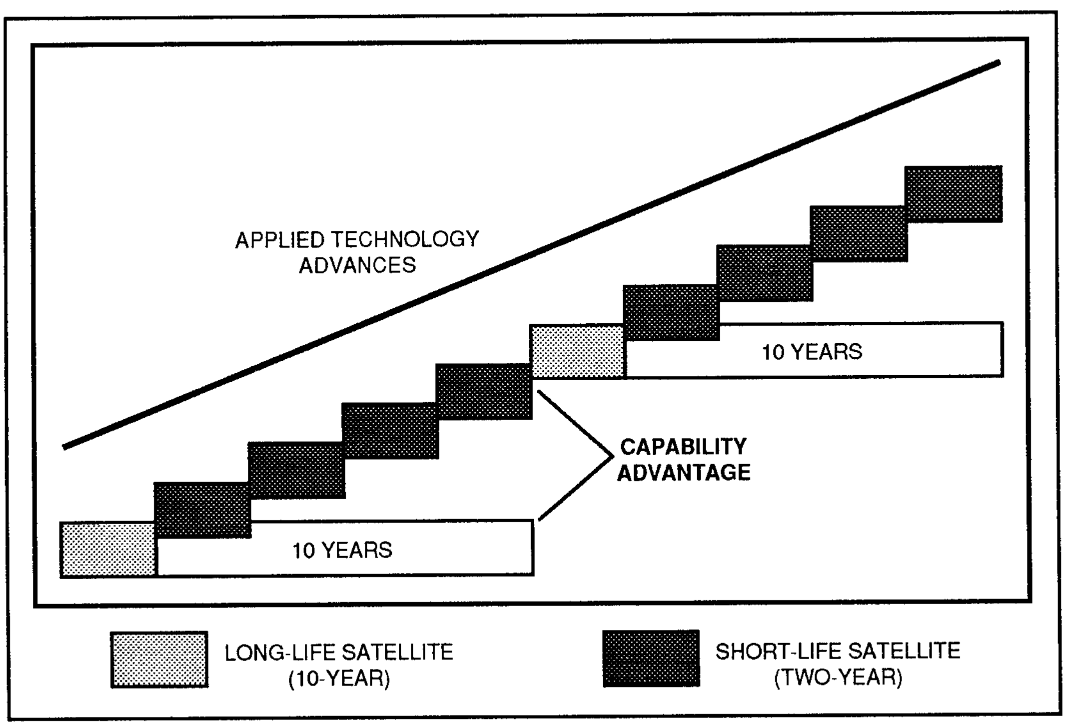


**Figure 5. Capability Advantage of Short-Life Satellites**

An operational RASFOR system could provide a more direct service to war fighters—it could serve as a platform for aerospace control and force application.[21] For example, RASFOR systems could be outfitted with payloads to perform offensive or defensive counterspace missions, or to conduct strategic attack missions. Such applications could make it possible to deploy precision-guided conventional munitions anywhere on the plant's surface within hours.[22]

Finally, and perhaps most important, RASFOR can provide the war fighter with *flexibility at the grand strategic level.* The MILSTAR satellite system has been criticized as being a cold-war system without a mission. Indeed, many of its subsystems were designed under the national security strategies reflecting a bipolar world under nuclear detente.[23] Because of the global changes that occurred during its long development period, the US is faced with a system that meets requirements that may no longer be valid. Implementing a military space structure that uses RASFOR (with short-life satellites) will provide a responsive system that can adapt to changes in national security strategy.

### Improved Development Process

RASFOR elements have several advantages in development and procurement over conventional spacelift and satellite systems. The emphasis on simplicity, standardization, and operational utility for the spacelift system, coupled with reduced subsystems for smaller and shorter-life lightsats, can lead to shorter development and procurement cycles. Standardization of system elements can result in increased development program stability and allow for multiyear procurements and incremental funding that can reduce program costs by as much as 35 percent.[24] In addition to cost savings, this approach also provides increased flexibility for future space systems. Also, standardized lightsat buses could provide the core for low-cost technology test beds to reduce technical risks and system costs.[25]

### Strengthened US Space Foundation

Although the primary objective of RASFOR systems should be to develop military spacelift capabilities, the implementation of such a program would definitely strengthen the national space-related industrial base. Civil and commercial applications are very likely, including nonspace-related spinoffs such as medical instruments.[26] However, benefits to the nonmilitary sector are not guaranteed. Industry may have to take some initiative, and even some risks, to benefit from RASFOR systems; the US government must fully support any such initiatives.

The development of turbojet-powered civilian transportation aircraft offers an example that could be applied to the RASFOR system development. The Boeing Aircraft Company developed and produced the B-47 and B-52 strategic bombers for the US Air Force. These aircraft were designed and built to provide a critical *military capability*—nuclear deterrence. Their design and procurement were not contingent upon commercial aircraft needs, and therefore no consensus building

outside military circles was required. The experience gained by Boeing was applied, at great risk to the company, to the development of the Dash 80.[27] This aircraft was the forerunner of the Boeing 707 commercial transportation aircraft, in essence being the forefather of all Boeing 700-series jets. The development came full circle back to the military when the Air Force decided to utilize Boeing's aircraft in a version modified for aerial refueling—the KC-135. This success story illustrates that the approach of military first, commercial application second, makes sense for RASFOR development.

## Summary

The benefits offered by rapid space force reconstitution systems are numerous: increased capability, operational utility and flexibility, and decreased vulnerability, risk, and cost. The next chapter recommends specific actions toward meeting the mandate for RASFOR and realizing its advantages.

### Notes

1. Ken Booth, *Strategy and Ethnocentrism* (New York: Holmes and Meier, 1979).

2. Headquarters, US Space Command, *The Case for Space,* white paper (Peterson AFB, Colo., 9 August 1993), 2.

3. Philip Kunsberg, "Space Infrastructure," in *Building a Consensus Toward Space: Proceedings of the Air War College 1988 Space Issues Symposium* (Maxwell AFB, Ala.: Air University Press, April 1990): 62.

4. Although previously thought to be crude, the spacelift systems of the FSU have proven to be very sophisticated. The reference to duct tape is not meant to demean their technology, but rather it is to serve as a tribute to the operational utility of their fault-tolerant systems.

5. De-evolution is *not* the same word as devolution. According to *Webster's II New Riverside University* Dictionary, devolution is "a passing down through successive stages," implying a deterioration or degradation. De-evolution is a term intended to show the reversal or retracing of an existing evolutionary path. For this paper, it primarily refers to de-evolving the development of current space launch vehicles to eliminate systems, infrastructure, and procedures that have compromised operational utility. This de-evolution will actually lead to enhanced, instead of degraded, vehicles.

6. Bill Gunston, *Attack Aircraft of the West* (London, Ian Allen Ltd., 1974), 173–75. Mr Gunston presents a concise and interesting case study of the F-111 aircraft development. One of the requirements that should have been addressed was that of speed at low altitudes: "If TAC had not insisted on a low-level Mach number of 1.2, but instead chosen M 0.95 (which would have in no way harmed the ability of the aircraft to penetrate), millions of dollars would have been saved and the requirement would have been met with ease."

7. "Report on the Department of Defense Space Investment Strategy," Service Coordination Draft (Washington, D.C.: Department of Defense, 24 January 1994), 1.

8. Ibid., 21.

9. Ivan Bekey, Richard Powell, and Robert Austin, "NASA Studies Access to Space," *Aerospace America* 32, no. 5 (May 1994): 42–43. This study lists the status quo life-cycle costs (for 1995 through 2030) of the Space Shuttle, DOD and NASA expendable launch vehicles, and spacelift-related infrastructure to be $233 billion in 1994 dollars, or $393 billion in real-year dollars.

10. Quoted in Richard G. Lipsey and Peter O. Steiner, *Economics,* 5th ed. (New York: Harper & Row, 1978), 156.

11. Ibid.

12. "Report on DOD Space Investment Strategy," 38.

13. Bruce A. Smith, "Explosion Halts Titan 4 Launches," *Aviation Week & Space Technology* 139, no. 6 (9 August 1993): 22. On 2 August 1993, a Titan IV launch from Vandenberg AFB exploded at 101 seconds into its flight. The cost of the failure is estimated to be between one and two billion dollars. The effects of this incident go beyond just the economics; it "put Titan 4 launches on hold and threatens further delays in the deployment of key national security spacecraft."

14. Lt Col James D. Martens, *Building Blocks in Space* (Maxwell AFB, Ala.: Air University Press, April 1990), 10. This report provides an excellent commentary on the challenges of developing standardized space systems.

15. Frank Morring, Jr., "Microtechnology Has Uses Beyond Aerospace," *Aviation Week & Space Technology* 140, no. 8 (21 February 1994): 87.

16. Lt Col Larry D. James, *Dual Use Alternatives for DOD Space Systems,* Air War College research report (Maxwell AFB, Ala.: Air University, April 1993), 17.

17. "Report on DOD Space Investment Strategy," 39. This report notes that "In some cases, however, space technologies and applications are specialized for national defense, and there is no customer for them except the DoD."

18. Jeffrey M. Lenorovitz, "White House Spurs Launcher Initiative," *Aviation Week & Space Technology* 140, no. 1 (3 January 1994): 20. In this article, Richard DalBello (assistant director of the Office of Science and Technology Policy for the Clinton administration) sums up the biggest problem with current civil/commercial/military spacelift consensus building: "The hardest part of getting what you want is knowing what you want."

19. An example of spacelift consensus building gone awry: The pursuit of a "next generation" spacelift system has been so mired in politics that it has done little more than change names from "Advanced Launch Development Program," to "Advanced Launch System," to "National Launch System," to its most recent incarnation "Spacelifter." (This constant change has prompted some to ironically refer to the program as "Shapeshifter.")

20. Morring, 87.

21. AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force,* vol. 1, March 1992, 6–7.

22. Lowell Wood, "The US Air Force in 2020," lecture to Air University Spacecast 2020 team, Maxwell AFB, Ala., Air War College, 27 October 1993.

23. Jim Abrams, "MILSTAR," Columbus, Ohio: The Associated Press via CompuServ Information Service, 16 March 1994.

24. "Report on DOD Space Investment Strategy," 42–43.

25. Ibid., 45. The Advanced Research Projects Agency has proposed two standard spacecraft buses and a standard payload interface for military communication satellites. One bus would be for 600-pound satellites (three- to five-year life), the other for 2,000-pound satellites (up to 10-year life). James R. Asker, "Pentagon Pressed to Use Smaller, Cheaper Satellites," *Aviation Week & Space Technology* 139, no. 6 (9 August 1993): 25–26.

26. Morring, 87.

27. R.G. Thompson, "Dash 80," *Smithsonian Air & Space* 2, no. 1 (April/May 1987): 62–64.

## Chapter 5

# Conclusions and Recommendations

*More than ever before, space is the "High Ground" that we must occupy.*

—National Military Strategy of the United States

Space doctrine is still in its infancy. The current version of Air Force space doctrine states that "space forces offer a new operational horizon from which all military forces can benefit by adding to their responsiveness and effectiveness."[1] The irony of this doctrine is that it carries through with its theme with regard to all military forces *except* space forces—the issue of increasing the responsiveness of space force support is almost ignored. Most of this doctrine details how to transmit data from space to surface forces and how to deny an enemy's capability to do the same. Little thought is given to how we will react when an enemy tries to deny our space forces.[2] The unstated assumption is that US satellites will always be in place when we need them and that existing reconstitution methods (repositioning, on-orbit spares) are sufficient; no proactive approach to space force reconstitution during combat is presented.[3]

Although the spacelift element of space force reconstitution is mentioned in current doctrine, it is given very low priority. Assured access to space is given lip service in joint and Air Force doctrine; both acknowledge the problems with current spacelift systems, but they do not consider the ramifications of these deficiencies in a combat environment.[4] This lackadaisical treatment of space force reconstitution in current doctrine could lead to disaster in our next space war. This deficiency can be corrected by implementing the following recommendations.

## Proactive Reconstitution

Chapter 2 clearly illustrated the dependence that joint war fighters have upon force enhancement provided by satellites. It also showed that rapid space force reconstitution (RASFOR) is needed to ensure that these critical assets are always available when and where they are needed. *The essential nature of RASFOR must be emphasized throughout space doctrine.*

## Tenets of Space Doctrine

In a combat environment, the capability to rapidly replace or augment satellites is essential to providing complete and flexible support to joint war fighters. Without this capability, a properly armed enemy can eliminate our satellites (active and spare) in order to nullify all force enhancement derived from them. If satellites are not available during wartime, then current space doctrine falls apart. An operational RASFOR system could ensure that satellites will always be available when needed—it must be recognized as the key enabler for space doctrine. Therefore, *RASFOR should be added as a tenet of US space doctrine.*[5]

## The Space Campaign

The options provided by a RASFOR system must be clearly understood by campaign planners, especially its ability to react to short-notice crises. *RASFOR should be integrated into space campaign doctrine.*[6]

## Requirements

The scope of operations that RASFOR must perform is unknown. Specific requirements must be determined as a basis for RASFOR development, and these requirements must be coherent with future combat scenarios. *As a minimum, the ability of current US space forces to meet two simultaneous major regional conflicts should be evaluated to determine the scope of RASFOR that is required.*[7] Other realistic scenarios should be considered, and the best- and worst-case features of space warfare should be included.

## Development and Acquisition

Once clear operational requirements have been determined for a RASFOR system, its force elements should be developed and acquired. As the service entrusted with aerospace control and exploitation, the Air Force should lead this effort. However, the *participation of all armed services in the requirements definition, development, and acquisition of RASFOR systems is paramount to their success in combat.* The design approaches discussed in chapter 4 should be emphasized during development. Also, the extensive use of prototype or X-vehicles should be included.

*RASFOR should be developed with a military-first approach* (chapter 4). RASFOR technologies and systems should be made available to commercial spacelift and satellites (as appropriate for security considerations). However,

it should be emphasized that the system may not pay for itself and that technological spinoffs, while predicted, are not guaranteed.

Acquisition of RASFOR systems should support an implementation time frame of the years 2002–2007. This time frame coincides with the projected time that current satellites (existing or in production) will require replacement to fulfill military needs.[8]

## Employment

Based on the advantages offered by RASFOR systems, the US should consider a fundamental space force structure change to include lightsat constellations. The actual employment of RASFOR systems should include a balance of elements dedicated for continuous alert as well as elements dedicated to routine replacement (with the option of moving to alert status during a crisis). For payloads which exceed the lift capabilities of RASFOR systems, the 90/10 weight split method with on-orbit assembly (chapter 4) could be used. Finally, RASFOR systems should maintain the operational flexibility to use their spacelift elements as force application platforms.

## Closure

"The ultimate objective of military space operations is the effective employment of space capabilities in support of land, sea and air operations to gain and maintain a combat advantage throughout the operational continuum and across the three levels of war."[9] Accomplishing this objective requires the employment of space forces when and where they are needed—an objective that can be met by rapid space force reconstitution. RASFOR must be an integral part of a balanced approach to military spacelift if the United States is to ensure its control over the ultimate high ground of space.

### Notes

1. Air Force Doctrine Directive 4, "Air Force Operational Doctrine: Space Operations," draft, November 1993, 1.

2. Ibid., 16. Figure 4-2 outlines defensive counterspace options, including an option to "reconstitute assets." However, this is one among many options; no further detail is given to this concept except the two words found in the figure. Also, most of the other options are passive measures that depend on existing assets in orbit. If these assets are taken away, so are the options.

3. Ibid., 23. The section "Crisis and Wartime Space Support" (paragraph 5.1.2.2) does not mention any form of reconstitution.

4. Ibid., 12, 16. Reference to spacelift is hidden under a subsection titled "Other Considerations" (paragraph 4.3.4.1), and it is not mentioned under the space role definition of "force support" (paragraph 3.1.4). The joint doctrine reference is found in paragraph 5.a.(3) of

Joint Pub 3-14, "Joint Doctrine, Tactics, Techniques, and Procedures (TTP) for Space Operations," final draft, 15 April 1992, iv–40.

5. The proper place to add RASFOR to current space doctrine is as a major heading under Air Force Doctrine Directive 4, chapter 4 (Tenets of Space Doctrine).

6. The proper places to integrate RASFOR into space campaign doctrine are under Air Force Doctrine Directive 4, chapter 5, paragraph 5.1.2.2, "Crisis and Wartime Space Support," and Joint Pub 3-14, chapter 3, paragraph 5, "Space Operations Mission Support."

7. In telephone conversations with officials at the Space Warfare Center, the National Test Facility, and the US Space Command J33Z (space exercise branch), the author determined that none of these organizations have conducted studies or exercises to determine if current US space forces could properly support the two simultaneous regional conflict scenarios used as a basis for the 1993 Bottom-Up Review.

8. "Report on the Department of Defense Space Investment Strategy," Service Coordination Draft (Washington, D.C.: Department of Defense, 24 January 1994), 2.

9. Joint Pub 3-14, III-3.

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